LBNL-40316
UC-000

THE MONITORING, EVALUATION, REPORTING, AND VERIFICATION OF CLIMATE CHANGE MITIGATION PROJECTS: DISCUSSION OF ISSUES AND METHODOLOGIES AND REVIEW OF EXISTING PROTOCOLS AND GUIDELINES

Edward Vine and Jayant Sathaye

Energy Analysis Program
Environmental Energy Technologies Division
Lawrence Berkeley National Laboratory
Berkeley, CA 94720

December 1997

Prepared for the U.S. Environmental Protection Agency
Climate Policy and Program Division
Office of Economics and Environment
Office of Policy, Planning and Evaluation

Maurice LeFranc, Project Manager

This work was supported by the U.S. Environmental Protection Agency through the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

ABSTRACT

Because of concerns with the growing threat of global climate change from increasing emissions of greenhouse gases, the United States and other countries are implementing, by themselves or in cooperation with one or more other nations (i.e., joint implementation), climate change mitigation projects. These projects will reduce greenhouse gas (GHG) emissions or sequester carbon, and will also result in non-GHG impacts (i.e., environmental, economic, and social impacts).

Monitoring, evaluating, reporting, and verifying (MERV) guidelines are needed for these projects in order to accurately determine their net GHG, and other, benefits. Implementation of MERV guidelines is also intended to: (1) increase the reliability of data for estimating GHG benefits; (2) provide real-time data so that mid-course corrections can be made; (3) introduce consistency and transparency across project types and reporters; and (4) enhance the credibility of the projects with stakeholders.

Any proposed MERV guidelines should reflect the following principles: they should be consistent, technically sound, readily verifiable, objective, simple, relevant, transparent, and cost-effective. In practice, tradeoffs will have to be made among some of these criteria: e.g., simplicity versus the technical soundness of a guideline, and high transaction costs and comprehensiveness.

In this paper, we review the issues and methodologies involved in MERV activities. In addition, we review protocols and guidelines that have been developed for MERV of GHG emissions in the energy and non-energy sectors by governments, nongovernmental organizations, and international agencies. We comment on their relevance and completeness, and identify several topics that future protocols and guidelines need to address, such as: (1) establishing a credible baseline; (2) accounting for impacts outside project boundaries through leakage; (3) net GHG reductions and other impacts; (4) precision of measurement; (5) MERV frequency; (6) persistence (sustainability) of savings, emissions reduction, and carbon sequestration; (7) reporting by multiple project participants; (8) verification of GHG reduction credits; (9) uncertainty and risk; (10) institutional capacity in conducting MERV; and (11) the cost of MERV.

Some of the MERV issues are of a generic nature, whose resolution would benefit all future MERV guidelines and protocols. These issues would best be addressed through an international consensus. The consensus should:

1. Clarify, at the earliest possible date, the accepted roles and responsibilities of national governments, private businesses, nongovernment organizations, and international organizations in the joint implementation accreditation process.

Clearer property rights would reduce MERV costs, by focusing these activities on the correct parties at an earlier point in time.

2. Initiate a process to certify nongovernment organizations to provide MERV services.

3. Provide guidance on the determination of a baseline. How long should a baseline remain "fixed" before a new baseline is developed? If new information becomes available after a project has been implemented, does the baseline have to remain fixed after implementation and as specified in a certification document, or can the baseline be adjusted?

4. Decide whether MERV guidelines could exclude certain types of projects that are most likely small in scale. Also, one could specify thresholds for an accumulation of projects in the economy above which significant indirect impacts are to be expected (e.g., if 5-10% of electricity generated in a country is affected by a project).

5. Decide when a country's laws and guidelines (e.g., environmental impact statements) apply; e.g., where an investor country funds a project in a host country, do the laws of the investor country apply? or the host country's? or both? And what happens if the laws from the two countries conflict?

6. Create a tribunal to resolve disputes over verification results and develop a set of MERV guidelines.

The COP and national governments should foster information exchange for joint implementation in general, and for MERV issues discussed in this report.

In conclusion, there is a need to collect, analyze, summarize and disseminate the best responses to the topics addressed in this report and currently being dealt with in existing climate change mitigation projects. The experience gained in these projects should be very helpful for formulating MERV guidelines for climate change mitigation projects, which is the next phase in our project.

TABLE OF CONTENTS

LIST OF TABLES

Acknowledgments

We would like to thank Maurice N. LeFranc, Jr. and Jackie Krieger of the U.S. Environmental Protection Agency, Climate Policy and Program Division, Office of Economics and Environment, Office of Policy, Planning and Evaluation for their assistance and comments on previous drafts of this paper. We would also like to express our appreciation for the following people who reviewed an earlier draft of this report: Ken Andrasko, Noreen Beg, Katherine Begg, Neil Bird, Alison Bos, Sam Fankhauser, Johannes Heister, Steve Meyers, Axel Michaelowa, Irving Mintzer, Pedro Moura Costa, Emilio Libre La Rovere, Mark Trexler, and Steve Wiel. This work was supported by the U.S. Environmental Protection Agency through the U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

CHAPTER 1. INTRODUCTION

In this chapter, we provide the context for this paper by briefly discussing international and U.S. efforts to reduce greenhouse gas emissions. After reviewing the key objectives of this paper (including the examination of the issues and methodologies involved in monitoring, evaluating, reporting, and verifying climate change mitigation projects), we focus on one of the key issues to be addressed in the development of new guidelines and protocols, the monitoring domain. We conclude by explaining how the guidelines and protocols will be invaluable for an international carbon trading system.

1.1. Background

Because of concerns with the growing threat of global climate change from increasing emissions of greenhouse gases, more than 166 countries (as of May 13, 1997) have become Parties to the U.N. Framework Convention on Climate Change (FCCC) (UNEP/WMO 1992). The FCCC was entered into force on March 21, 1994, and the Parties to the FCCC are now in the process of negotiating a new legal instrument (either as an amendment or a protocol) to be adopted in December 1997. Under the FCCC, Annex 1 countries (i.e., the developed countries) are required to reduce their emissions in the year 2000 to 1990 levels. Non-Annex 1 countries (i.e., developing countries and countries in transition) do not have this requirement.

In July 1996, the United States outlined a broad framework for negotiation of next steps under the FCCC, and in December 1996, the U.S. further elaborated its ideas by describing the key elements that should be discussed for inclusion in a protocol to guide greenhouse gas (GHG) emission reduction efforts in the post-2000 period. In January 1997, the U.S. presented a draft protocol to the FCCC's Secretariat for consideration in international negotiations in 1997. In this case, the "protocol" does not refer to a set of project-specific guidelines or methodologies. Instead, the protocol simply establishes a framework for addressing the following key topics at the national level:[1] emissions targets; reporting and compliance; advanced developing country efforts; emissions trading and joint implementation; and long-term effects under the FCCC.

[1] An exception are joint implementation projects, which are international in scope and refer to cooperative development projects that seek to reduce or sequester GHG emissions and involve parties in two or more cooperating countries. Some of the issues confronting joint implementation projects are discussed in this paper.

The second topic (reporting and compliance) is the focus of this paper. The U.S. proposal establishes procedures to ensure the reporting and measurement of anthropogenic emissions by sources, and removals by sinks, of greenhouse gases at the national level.[1] For example, countries would have to set national systems for measuring emissions accurately, achieving compliance with emissions targets, and ensuring enforcement for meeting emissions targets. Also, annual reports on measurement, compliance and enforcement efforts at the national level would be required and made available to the public. The preparation of such reports involves many complex analytical and institutional issues as they relate to climate change mitigation projects, as discussed in this paper.

1.2. Objectives of the Paper

The primary purpose of this paper is to review the issues and methodologies involved in monitoring, evaluating, reporting, and verifying (MERV) climate change mitigation projects in order to provide guidance for the development of new protocols and guidelines for these activities. In the context of this study, protocols refer to specific rules that must be followed (e.g., methods for measuring soil carbon), while guidelines are more general (e.g., topics to address). We also review the way existing GHG and non-GHG protocols and guidelines address MERV issues. This report covers all climate change mitigation projects, including Joint Implementation (JI) and Activities Implemented Jointly (AIJ) projects (see below).

The focus of this paper is: (1) at the project level, not at the program level (e.g., utility energy-efficiency programs, or national joint implementation programs); (2) primarily at the local level with well-defined system boundaries, not at the national level; and (3) on the issues and methodologies related to the MERV of climate change mitigation projects, not the actual development of guidelines or protocols (the subject of the next phase of our study). The target audience of this report is primarily government policymakers, but we hope that this report will also be useful for project developers and investors, nongovernmental organizations, and the research community.

Climate change mitigation projects typically proceed through three phases: (1) project development (e.g., bringing together project investors and hosts, preparing feasibility studies, estimating the GHG reduction, and negotiating contracts); (2) project implementation (e.g., training project staff, implementing the project, managing the project finances, and preparing reports); and (3) project

[1] GHG sources include emissions from fossil fuel combustion, industry, deforested biomass, soil carbon loss in deforested areas, methane from agricultural activities, etc. GHG sinks include storage in the atmosphere, ocean uptake, and uptake by forest regrowth and sequestration from carbon accumulation (IPCC 1995; Andrasko et al. 1996).

assessment (e.g., monitoring and evaluating the project, calculating the GHG reductions, and verifying the GHG reduction) (Watt et al. 1995). MERV activities can occur in all project phases, for example: (1) the U.S. Initiative on Joint Implementation has an Evaluation Panel that evaluates project submissions during the project development stage (Section 2.1.1); (2) projects could be designed to reduce subsequent MERV difficulties, for example, by addressing leakage, defining baselines, and calculating GHG benefits; and (3) inclusion of easily measurable performance indicators during project development which are correlated to project objectives and which are used in project assessment (personal communication from Samuel Fankhauser, World Bank, Aug. 27, 1997).

The focus of this paper is on project assessment (after a project has started implementation) and the following MERV activities:

1. Monitoring: refers to the measurement of GHG reductions[1] and other associated socioeconomic and environmental impacts and activities that actually occur as a result of a project. Monitoring does *not* involve the calculation of GHG reductions nor does it involve comparisons with previous baseline measurements. For example, monitoring would involve the measurement of kilowatts produced by a wind generator, or the number of hectares preserved by a forestry project. The objectives of monitoring are to inform interested parties about the performance of a project, to adjust project development, to identify measures that can improve project quality, to make the project more cost-effective, to improve planning and measuring processes, and to be part of a learning process for all participants (De Jong et al. 1997).

2. Evaluation: refers to both impact and process evaluations of a particular project, typically entailing a more indepth and rigorous analysis of a project compared to monitoring emissions. Project evaluation usually involves comparisons requiring information from outside the project in time, area, or population (De Jong et al. 1997). The calculation of GHG reductions is conducted at this stage. Project evaluation would include GHG impacts, non-GHG impacts (i.e., environmental, economic, and social impacts), determination of the proper baseline, estimation of leakage and project spillover, etc. Evaluation organizes and analyzes the information collected by the monitoring procedures, compares this information with

[1] GHG reductions refer to GHG emission reductions or carbon sequestration in this paper. Carbon sequestration refers to the process where carbon is absorbed or taken out of the atmosphere and stored in a terrestrial or oceanic reservoir. This differs from the preservation of existing carbon stocks in a reservoir.

information collected in other ways, and presents the resulting analysis of the overall performance of a project. Project evaluations will be used to determine the official level of GHG emissions reductions and carbon sequestration that should be assigned to the project. The focus of evaluation is on projects that have been implemented for a period of time, not on proposals (i.e., project development).

3. Reporting refers to *measured* GHG and non-GHG impacts of a project (in some cases, organizations may report on their *estimated* impacts, prior to project implementation, but this is not the focus of this paper). Reporting occurs throughout the MERV process (e.g., periodic reporting of monitored results and a final report once the project has ended).

4. Verification refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, certified party.

These activities have different objectives and timing, but they potentially have much overlap and interactions among each other as well as among the institutions that might perform these activities (Section 3.10.1).

MERV tasks are expected to include many of the following types of activities:

- installation and operation of equipment, measures and systems
- measurement, data collection, and analysis
- institutional development
- estimation of baseline conditions
- calculation of the amount of energy saved and supplied, GHG emissions and GHG emission reductions, amount of carbon sequestered, and non-GHG impacts (see below)

In this paper, we consider three types of projects: energy efficiency, renewable energy (including bioenergy projects), and forestry. We believe that other kinds of energy projects (e.g., cogeneration and fuel switching) will use methods and approaches similar to those described here. For each of these types of projects, we also discuss appropriate MERV methods (Chapters 4 and 5).

1.2.1. Monitoring domain

One of the key issues in the development of guidelines and protocols is the domain of monitoring that might be envisioned for a particular project. The domain that needs to be monitored (i.e., the monitoring domain, see Andrasko 1997 and MacDicken 1997) is typically viewed as larger than the geographic and temporal boundaries of the project. Consideration of the domain accounts for the following issues: (1) the temporal and geographic extent of a project's direct impacts; (2) upstream and downstream coverage of indirect energy impacts and pre- and post-harvest coverage of indirect forestry impacts; (3) national and international leakage; and (4) off-site (i.e., outside of the project area) baseline changes. If one of the objectives of the guidelines is to provide the capability to compare GHG reductions across projects, then the guidelines need to be consistent in requesting information at the same monitoring domain.

The first monitoring domain issue concerns the appropriate geographic boundary for evaluating and reporting impacts. A climate change mitigation project might have local (project-specific) impacts that are directly related to the project in question, or the project might have more widespread (e.g., regional) impacts. Thus, one must decide the appropriate geographic boundary for evaluating and reporting impacts.

The second monitoring domain issue is related to time and location. For example, energy projects may impact energy supply and demand at the point of production, transmission, or end use. The MERV of such impacts will become more complex and difficult as one attempts to monitor how emission reductions are linked between energy end users and energy producers (e.g., tracking the emissions impact of 1,000 kWh saved by a household in a utility's generation system). Similarly, the MERV of emissions of forestry projects can be conducted at the point of extraction (e.g., when trees are logged) or point of use (e.g., when trees are made into furniture), and when forests are later transformed to other uses (e.g., agriculture, grassland, or range). Thus, one needs to decide whether MERV should focus solely on the emissions from the logging of trees at the project site, monitor the emissions over time from the new land use type, or account for the wood products produced and traded outside project boundaries.

The third and fourth monitoring domain issues occur when questions of "leakage" and off-site baseline changes (i.e., changes occurring outside of the project area) need to be addressed. For example, leakage occurs if a natural forest area, previously used to meet local needs for timber and firewood, is closed due to a preservation project and, as a result, fuelwood and timber are harvested elsewhere (MacDicken 1996; Watt et al. 1995). In addition, some projects may involve international leakages: e.g., in 1989, when all commercial logging in Thailand was banned, the logging shifted to neighboring countries such as Burma, Cambodia and Laos as well as to Brazil. And in energy-efficiency projects, leakage occurs, for example, when innovative building design practices are used by builders outside of the project areas where these practices were first introduced. Leakage needs to be accounted for if off-site GHG emissions are to be accounted for, rather than those at a particular site. Accordingly, the development of baselines (see below) and the level of MERV in general will be affected by the choice of the monitoring domain.

These problems point out the difficulty of establishing a credible baseline. One could broaden the monitoring domain to include, for example, leakage and off-site baseline changes. Widening the system boundary, however, will most likely entail greater MERV transaction costs. Transaction costs are the costs incurred by the people responsible for monitoring, reporting, evaluating, and verifying climate change mitigation projects. These costs include not only out-of-pocket expenditures, but also opportunity costs (e.g., the lost time (delay) and resources (e.g., money and managerial attention) that could have been devoted to the next best opportunity for that participant (Dudek and Weiner 1996). We revisit these issues later in this paper (Section 3.3.1), but warn the reader that these questions may have to be resolved through an international consensus, rather than addressed through the guidelines or protocols.

1.2.2. Carbon credits and trading

The MERV guidelines will be important management tools for all parties involved in carbon mitigation. They will help project participants determine how effective their contributions have been in curbing GHG emissions, and they will help planners and policy makers in determining the potential impacts for different types of projects, and for improvements in project design and implementation. And they will also be needed for ensuring consistency and transparency across project types and sectors.

In the longer term, MERV-type guidelines will be a necessary element of any international carbon trading system. It is by no means certain that such a system will emerge.[1] In the U.S. draft protocol to the Framework Convention on Climate Change (Jan. 17, 1997), however, the U.S. proposed international emissions trading (Article 6) in which countries could transfer or receive any of its tons of carbon equivalent emissions allowed for a budget period, for the purpose of meeting its obligations. In addition, tons of carbon equivalent emissions reduced by Joint Implementation projects could be transferred to other countries as part of an international emissions trading system (Article 7). The World Bank's Global Carbon Initiative is also researching various mechanisms and instruments to facilitate a carbon offsets market, one of which is the feasibility of a Carbon Investment Fund (World Bank 1997a).

---

[1] Presently, there are no emission credits associated with joint implementation (JI) projects in the pilot phase for joint implementation (or "activities implemented jointly" (AIJ)) under the FCCC (Conference of Parties, Decision 5/CP.1 (Dec. 1995)). Once the AIJ pilot ends, a GHG credit trading regime may emerge. Nevertheless, at the core of the concept of AIJ projects is the need to measure and verify GHG emission reductions, so that the international community can gain experience with and determine the feasibility of measuring GHG emission reductions from AIJ.

Under one version of an international emissions trading system, countries would agree to an allocation of maximum emissions for each GHG (see World Bank 1994a). Emissions over the limit would be allowed only if a country purchased additional emission allowances from other countries, or if the country initiated activities that would offset the increase by a decrease in emissions from other activities. A country could also generate saleable allowances by implementing projects that result in a net reduction in emissions. The valuation of such projects will require MERV-type guidelines that are acceptable to all parties. These guidelines will yield verifiable findings, conducted on an ex post facto basis (i.e., actual as opposed to predicted project performance).

It is likely that an international carbon trading regime will require project monitoring of all pools that are likely to decrease or increase over time. For carbon mitigation projects, a key factor will be the relative cost of MERV activities compared to the economic value of fixed or avoided carbon. For example, if carbon credits are worth $10 per ton, it does not make economic sense to spend $20 per ton on MERV. We do not discuss emissions trading issues and guidelines in this report, but simply note the context in which the cost of MERV activities needs to be discussed.

1.3. Organization of the Paper

The rest of this paper is organized into five chapters. In Chapter 2, we review existing protocols and guidelines, some of which are related to greenhouse gases. In Chapter 3, we examine the issues that are generic to the projects under discussion. In the next two chapters (Chapter 4 and 5), we discuss methodological issues in detail (e.g., use of engineering models and explanations of how carbon content in wood and other material is measured) in the energy and forestry sectors, respectively. Readers can skip these chapters and proceed to Chapter 6 where we summarize our review of existing protocols and guidelines as they relate to the issues described in the previous chapters, and where we present our key conclusions.

CHAPTER 2. EXISTING PROTOCOLS AND GUIDELINES

Prior to discussing the issues involved in the development of MERV protocols and guidelines, we briefly review protocols and guidelines that already exist. We divide them into two categories: (1) protocols and guidelines related to greenhouse gases and (2) protocols and guidelines not related to greenhouse gases. In this paper, protocols typically refer to project-specific methodologies and MERV requirements that need to be followed, while guidelines are more general and strict adherence to them is not expected. We briefly describe the protocols and guidelines in this section and later use examples from them to illustrate key points in the paper.

2.1. GHG-Related Protocols and Guidelines

We are aware of seven protocols and guidelines related to greenhouse gases:

1. U.S. Initiative on Joint Implementation's (USIJI) project proposal guidelines
2. Subsidiary Body for Scientific and Technological Advice's (SBSTA) uniform reporting format guidelines
3. World Business Council for Sustainable Development's (WBCSD) proposal guidelines
4. World Bank's monitoring and evaluation guidelines
5. U.S. Department of Energy's (DOE) voluntary reporting guidelines for greenhouse gases
6. Winrock 's carbon monitoring guidelines
7. SGS Forestry's carbon offset verification guidelines

The USIJI, SBSTA, and WBCSD guidelines provide general guidance for preparing project proposals. The World Bank and DOE guidelines contain general methodologies for calculating GHG emissions. And the Winrock and SGS guidelines provide specific methodologies and guidance for forestry-related projects. At the end of this paper, we review how these guidelines address the MERV issues discussed in this paper.

2.1.1. USIJI's project proposal guidelines

The U.S. Climate Change Action Plan, announced on Oct. 19, 1993, set forth a series of measures designed to return U.S. greenhouse gas emissions to 1990 levels by the year 2000 largely through voluntary domestic actions. Recognizing the enormous potential for cost-effective GHG emission reductions in other countries, the Plan provided for a pilot program — the U.S. Initiative on Joint Implementation (USIJI) — to help establish an empirical basis for considering approaches to joint implementation internationally and thus help realize the potential of joint implementation both to combat the threat of global climate change and to promote sustainable development.[1]

USIJI is the first and currently most developed joint implementation pilot program worldwide. In 1996, the USIJI prepared project proposal guidelines for organizations seeking funding from investors to reduce GHG emissions (USIJI 1996). By complying with the guidelines and obtaining approval from the U.S. government and the government of the host country, project proponents receive institutional credibility (e.g., by receiving government recognition), technical credibility (e.g., by meeting USIJI criteria and clearly documenting emissions reductions), and public recognition (e.g., by receiving a certificate at an awards ceremony) (personal communication from Jackie Krieger, USIJI, Sept. 26, 1997). In addition, they receive technical assistance in interpreting the USIJI criteria, calculating and documenting reference- and project-case GHG emissions, working with the governments of the host countries, and reporting to the UNFCCC.

The guidelines request information on the proposed project, including the identification of all GHG sources and sinks included in the emissions baseline as well as those affected by the proposed project, and net impacts (see Section 3.3.2). The guidelines also ask for information on the estimates of GHG emissions and sequestration, including methodologies, type of data used, calculations, assumptions, references and key uncertainties affecting the emissions estimates. The estimates include the baseline estimate of emissions or sequestration of GHG without measures and the estimate of emissions or sequestration of GHG with measures.

The guidelines require applicants to describe the process used to monitor GHG reductions, including the parties responsible for monitoring GHG emissions and reductions, the specific data that will be collected in monitoring GHG reductions, and data collection procedures (sampling methodologies, emissions monitoring equipment, and estimation methodologies). Furthermore, the guidelines ask the applicant to describe the provisions in the project for external verification of GHG emission reductions

[1] Department of State Public Notice 1918 (58 FR 66057-66059, Dec. 17, 1993) set forth the draft Groundrules for the U.S. Initiative on Joint Implementation to provide for the operation of a pilot program. Following the public comment period, the revised final Groundrules were published in Department of State Public Notice 2015 (59 FR 28442-28446, June 1, 1994).

or sequestration. USIJI requires participants to allow external verification of GHG emissions reductions or sequestration by an Evaluation Panel, its designee, or a party(ies) named at a later date subject to approval by the Evaluation Panel. Such verification may include third-party inspection of documentation of emissions reductions, or site visits to the project.

In addition to the guidelines themselves, one of the key features of the USIJI is the Evaluation Panel, consisting of members from: the U.S. Department of Energy; the U.S. Environmental Protection Agency; the State Department; the Agency for International Development; the Departments of Agriculture, Commerce, Interior, and Treasury; and others as necessary. The Evaluation Panel has several responsibilities including reviewing, evaluating, and accepting project submissions that meet program criteria.

2.1.2. SBSTA's Uniform Reporting Format guidelines

The Framework Convention on Climate Change's (FCCC) Subsidiary Body for Scientific and Technological Advice (SBSTA) recently developed a Uniform Reporting Format (URF) for activities implemented jointly under a pilot program (Appendix B); the format was approved by the SBSTA as part of the implementation of the FCCC (SBSTA 1997).[1] The project proposers need to quantify the projected emission reductions for their project baseline scenario, project activity scenario, and cumulative effects for carbon dioxide, methane, nitrous oxide, and other greenhouse gases. One of the unique features of the URF is the section on benefits (environmental, social/cultural, and economic): quantitative information is requested, but if not available, qualitative information should be given. Project proposers need to describe how their project is compatible with, and supportive of, national economic development and socioeconomic and environmental priorities and strategies.

Furthermore, the URF requests information on the "practical experience gained or technical difficulties, effects, impacts or other obstacles encountered" (either quantitatively or qualitatively). The impacts include environmental, social/cultural, or economic impacts. In addition to the United States, other countries that have developed proposal guidelines based on the URF include: Australia, Costa Rica, Japan, Norway, Poland, Sweden, and Switzerland (Appendix C).

[1] The SBSTA is one of the most prominent organizations involved in the discussion of joint implementation issues, including MERV issues.

2.1.3. WBCSD's project proposal guidelines

The World Business Council for Sustainable Development (WBCSD) has prepared guidelines, similar to the URF guidelines, for detailed proposals in order to attract investors to invest in climate change mitigation projects (Appendix D; for more information on the WBCSD, see their home page on the World Wide Web: http:// www.wbcsd.climatechange.com/home.html). One section of the guidelines covers monitoring and reporting, such as a discussion of the parties responsible for the monitoring, the specific data that will be used to monitor GHG reductions, a schedule for monitoring, and data collection procedures. The data collection procedures section asks for a description of the sampling methodologies, emissions monitoring equipment (where relevant), use of remote sensing (where relevant), and methodologies for estimating emissions reductions from the raw data. The guidelines contain a brief section on external verification: project proposers need to name the organization(s) responsible for conducting external verification of project activities and records, the frequency of the verification, and what aspects of the project will be verified.

One of the unique features of the WBCSD guidelines is a requirement for a "contingency plan" that identifies potential project risks and a discussion of the contingencies provided within the project estimates to manage the risks. Similarly, in another part of the guidelines, proposers need to identify and discuss the key uncertainties affecting all emissions estimates. Proposers also have to identify any potential source of leakage and describe the steps that will be taken to reduce the risks of potential leakage, or to ensure that the benefits of the proposed project would not be lost or reversed in the future due to leakage.

2.1.4. World Bank's monitoring and evaluation guidelines

The World Bank prepared monitoring and evaluation guidelines for the Global Environment Facility (GEF), a multilateral funding program created to support projects that yield global environmental benefits but would not otherwise be implemented because of inadequate economic or financial returns to project investors (World Bank 1994a). The GEF supports four types of projects: biodiversity preservation, pollution reduction of international waters, GHG emission reduction and, to a limited extent, the control of ozone-depleting substances.[1] This document is written for the consultants who will be engaged to conduct monitoring and evaluation tasks under GEF-earmarked funding.

[1] The control of ozone-depleting substances such as chlorofluorocarbons (CFCs) is primarily addressed under a separate multilateral program, the Montreal Protocol.

The monitoring and evaluation framework presented in this report differentiates projects according to the underlying physical GHG abatement processes:

a. *Biomass production*: stores (or sequesters) carbon in the form of the complex sugars that compose biomass;

b. *Fuel substitution*: replaces one type of fuel with another that produces less net GHG emissions upon combustion or transformation;

c. *Energy conservation*: reduces the amount of carbon fuel-derived energy that must be generated, transmitted or consumed to provide a given level of end-use service; and

d. *Direct capture* of greenhouse gases, followed by the storage or use of these gases.

The guidelines address both the institutional and technical dimensions of evaluation for GHG abatement projects and are referenced later in this report.

The World Bank has also developed a new analytical tool, called global overlays, that integrates GHG externalities into the Bank's economic and sector work (World Bank 1997b). These guidelines were prepared within the context of the FCCC and were developed for the energy and forestry sectors. The guidelines describe the steps involved in (1) estimating a baseline emissions inventory, (2) screening a broad range of GHG mitigation options, and (3) developing a mitigation scenario. While not targeted to project monitoring and evaluation, some of the basic concepts presented in this report may be useful for MERV activities.

2.1.5. DOE's voluntary reporting of greenhouse gases

The U.S. Department of Energy (DOE) prepared guidelines and forms for the voluntary reporting of greenhouse gases (DOE 1994a and 1994b). The guidelines and forms can be used by corporations, government agencies, households and voluntary organizations to report to the DOE's Energy Information Administration on actions taken that have reduced or avoided emissions of greenhouse gases. The documents offer guidance on recording historic and current GHG emissions, emissions reductions, and carbon sequestration. There is also guidance on such issues as joint reporting (if two or more organizations are responsible for achievements), third-party reporting (e.g., through a trade association), international projects, confidentiality, certification, and other elements of the reporting process.

The supporting documents (DOE 1994b) contain limited examples of project analysis for the following sectors: electricity supply, residential and commercial buildings, industrial, transportation, forestry, and agriculture. Each volume includes appendices that provide conversion tables and default emission factors (for various fuels and for electricity on a state-by-state basis), as well as a list of greenhouse gases for which the Intergovernmental Panel on Climate Change has developed Global Warming Potentials (an index of the relative effects on climate of different gases).[1]

Emissions information could include data on the entire organization and all its greenhouse gas activities, including historic baseline emissions data for 1987 through 1990 (the "baseline period"), and annual emissions for subsequent years. The types of greenhouse gases and other radiatively enhancing gases are described in Section 3.2.1. Comprehensive information about emissions reduction projects could include both emissions reductions and carbon sequestration projects, emissions factors used to determine reductions, assumptions about the project, and data sources. Both direct and indirect emissions can be reported: direct emissions result directly from fuel combustion or other processes that release greenhouse gases on-site, while indirect emissions occur when activities cause emissions to be generated elsewhere. As an example (from this report), a manufacturer would report as direct emissions the carbon dioxide emitted from the stack of its assembly plant. The same manufacturer could report indirect emissions from the electricity used to light that assembly plant, since the electricity use causes emissions to be generated by an electric utility.

2.1.6. Winrock's carbon monitoring guidelines

The Winrock International Institute for Agricultural Development published a guide to monitoring carbon sequestration in forestry and agroforestry projects (MacDicken 1996).[2] The guide describes a system of cost-effective methods for monitoring and verifying, on a commercial basis, the accumulation of carbon in forest plantations, managed natural forests and agroforestry land uses. This system is based on accepted principles and practices of forest inventory, soil science and ecological surveys. Winrock's monitoring system assesses changes in four main carbon pools: above-ground biomass, below-ground biomass, soils, and standing litter crop. It aims to assess the net difference in each pool for project and non-project (or pre-project) areas over a specified period of time.

---

[1] The Intergovernmental Panel on Climate Change (IPCC) has compiled a list of emission factors, too (IPCC 1995).

[2] WIIAD is a nonprofit organization whose mission is to work with people to build a better world by increasing agricultural productivity and rural employment while protecting the environment. Winrock's Forest Carbon Monitoring Program is supported by the US AID Center for Environment, Winrock International and a wide range of private, nongovernment, and government sponsors.

The Winrock monitoring system covers the following components:

1. Determination of a baseline on pre-project carbon pools in biomass, soils, and standing litter crop.
2. Establishment of permanent sample plots for periodic comparative measurement of changes in carbon pools.
3. Plotless vegetation survey methods to measure carbon stored in nonproject areas or areas with sparse vegetation.
4. Calculation of the net differences in carbon accumulated in project and nonproject land uses.
5. Use of satellite images as gauges of land-use changes, and as base maps for a microcomputer-based geographic information system.
6. Software for calculating minimum sample size, assigning sample unit locations, determining the minimum spacing for plots, and optimizing site-specific monitoring plans.
7. Computer modeling of changes in carbon storage for periods between field measurements.
8. A database of biomass partitioning (roots, wood and foliage) for selected tree species.

The system has been field tested on six sites located in Brazil, Belize, the Philippines and the United States and is now in use, or planned for use, in over 950,000 hectares in six countries (MacDicken 1997).

2.1.7. SGS Forestry's Carbon Offset Verification Service

SGS Forestry's Carbon Offset Verification Service is the first international third-party verification service of forestry-based carbon offset projects (EcoSecurities 1997; Moura Costa et al. 1996).[1] The service consists of a formal analysis of project concept and design, and an independent quantification and verification of projected and achieved carbon savings derived from the project. SGS Forestry's methodology covers the following components: (1) suitability assessment of project design, to determine whether the project fulfills SGS Forestry's carbon offset project eligibility criteria; (2) assessment of the project's scientific methodology, focusing on data quality and statistical analysis; (3) verification of projections of net carbon flows derived from the project by quantifying carbon flows of with- and

[1] Carbon offset is the result of any action specifically taken to remove from, or prevent the release of, carbon dioxide into the atmosphere in order to balance emissions taking place elsewhere. Carbon offsets are synonymous with GHG reductions (i.e., GHG emission reductions and carbon sequestration).

without-project (baseline) scenarios, using SGS Forestry's Carbon Quantification Model; and (4) a surveillance program for assessment of project development and verification of achieved offsets.

The SGS service is designed to provide a greater confidence for carbon offset projects, regulation and transactions, by being an impartial third-party with a uniform evaluation methodology. SGS Forestry is not a judge in accepting or rejecting the validity of particular projects. SGS defers the ultimate judgment regarding the acceptability of particular projects and transactions to regulators in the countries involved.

SGS Forestry's carbon offset project eligibility criteria include the following: (1) acceptability (at national and international levels); (2) additionality (e.g., emissions and financing); (3) externalities (including leakage and social and environmental impacts); and (4) capacity (e.g., management, financial, infrastructure, technology and verification expertise and resources).

SGS Forestry's Carbon Quantification Model is used to assist the verification of the initial projections of carbon flows. The model is based on the following carbon pools and their flows: (1) trees (above and below ground components); (2) other vegetation; (3) necromass (fine and coarse litter, dead trees, etc.); (4) soil carbon; and (5) wood products (including their primary and secondary utilization and conversion rates).

SGS Forestry's surveillance program consists of periodic verification of carbon achievements, concentrating on field implementation and field data gathered by the project's internal monitoring program, such as field inspections, verification of field books, calculations, field audits, reports, etc. Based on the results of assessments carried out during the surveillance visits, SGS Forestry will issue certificates stating the amount of carbon fixed by the project up to the date of the most recent assessment.

SGS Forestry is now adapting its methodology to fulfill the characteristics of Costa Rica's national carbon acquisition program. This program, coordinated by the Costa Rican Office for Joint Implementation, will attract part of its financing through the international sale of Certified Tradable Offsets.

2.2. Non-GHG-Related Protocols and Guidelines

We are aware of four protocols and guidelines that are not directly related to greenhouse gases but may serve as examples of the way the protocols and guidelines could be developed:

1. DOE's energy measurement and verification protocols
2. EPA's acid rain monitoring protocols
3. EPA's Conservation Verification Protocols
4. Dutch reporting and monitoring guidelines

DOE's energy measurement and verification protocols contain recent, international guidelines being used for evaluating energy-efficiency projects and provides a flexible approach for addressing the monitoring and verification needs of different stakeholders and projects. In contrast to the other protocols and guidelines in this report, EPA's acid rain monitoring protocols are involuntary and have been used for years in monitoring energy projects for conformance with national air quality legislation (the Clean Air Act). EPA's conservation and verification protocols have been used by several utilities in obtaining air quality credits for their energy-efficiency projects. The Dutch reporting and monitoring guidelines are being used by Dutch industries for their energy-efficiency projects as part of their voluntary agreements with the Dutch government.

2.2.1. DOE's energy measurement and verification protocols

The U.S. Department of Energy (DOE) prepared the International Performance Measurement and Verification Protocol (IPMVP, formerly called the North American Energy Measurement and Verification Protocol) as a consensus document for measuring and verifying energy savings from energy-efficiency projects (Kats et al. 1996 and 1997; Kromer and Schiller 1996; U.S. Department of Energy 1996b).[1] A key element of the IPMVP is the definition of two measurement and verification (M&V) components: (1) verifying proper installation and the measure's potential to generate savings, also stated as confirming that (a) the baseline conditions were accurately defined and (b) the proper equipment/systems were installed, were performing to specification, and had the potential to generate the predicted savings; and (2) measuring (or estimating) actual savings. The general approach to

[1] The protocol can be obtained by calling the Federal Energy Management Program (FEMP) at 800-566-2877, or can be downloaded via the World Wide Web through the U.S. Department of Energy's home page: http://www.eren.doe.gov. The protocol is listed under the topic: "Building systems and community programs."

verifying baseline and post-installation conditions involves inspections, spot measurement tests, or commissioning activities.[1]

The IPMVP was built around a common structure of three M&V options (Options A, B, and C). These three options were based on the two components to M&V defined above. The purpose of providing several M&V options is to allow the user flexibility in the cost and method of assessing savings. A particular option is chosen based on the expectations for risk and risk sharing between the buyer and seller and onsite and energy-efficiency project specific features. The options differ in their approach to the level and duration of the verification measurements. None of the options are necessarily more expensive or more accurate than the others. Each has advantages and disadvantages based on site specific factors and the needs and expectations of the customer.

1. The first option, A, focuses at the system level and uses short-term measurements for verifying actual achieved energy savings of end-use technologies during the term of the contract. This enables the contracting parties to confirm that the proper equipment components or systems were installed and that they have the potential to generate the predicted savings. This option is recommended for projects where a significant portion of the associated uncertainty is in verifying the performance of the energy efficiency measure (e.g., equipment quantities and ratings such as lamp wattages, motor kW, or boiler efficiency).

2. The second option, B, focuses at the system level, but uses continuous or regular interval measurements. This provides the additional capability to determine an energy and costs savings value using end-use technologies data taken throughout the term of the contract, thereby accounting for operating variations.

3. The third option, C, uses measurements taken at the whole building or whole facility level, and uses continuous or regular interval measurements for verifying actual energy savings achieved facility-wide during the term of the contract. It addresses aggregate, coincident demand and energy savings from multiple resources at a single site. This provides for the measurement and verification of the impact of energy efficiency measures that are not directly measurable, such as increasing insulation or installing low-e windows.

The first version of the IPMVP was published in February 1996 and updates are planned for 1997 and beyond. The IPMVP has been adopted for use by four states (California, Florida, Iowa, and New York) and is being applied in the federal sector in Mexico. The IPMVP is being translated into seven languages (Czech, French, Hungarian, Polish, Portuguese, Russian, and Spanish) for implementation internationally (Kats et al. 1996 and 1997). The World Bank has adopted IPMVP for a $300 million energy efficiency loan to Russia — the largest efficiency loan ever. U.S. DOE is working with The World Bank and the U.S. Agency for International Development to use the IPMVP to develop other

[1] Commissioning is the process of documenting and verifying the performance of energy systems so that the systems operate in conformity with the design intent.

large-scale efficiency loans. In 1997, the protocol will be extended to include water efficiency (as well as energy efficiency), new buildings (as well as existing buildings), and indoor air quality issues.

2.2.2. EPA's Acid Rain monitoring forms and instructions

When the U.S. Clear Air Act was re-authorized in 1990, it included a program to control acid rain (Palmisano 1996). Title IV of the 1990 Act limits electric utilities' emissions of SO_2 and NO_x. Title IV created a regulatory regime to reduce the costs of meeting these emissions limits by allowing utilities to choose cost-effective pollution controls. Under Title IV, the U.S. Congress combined emissions trading concepts with strict monitoring requirements to ensure that new SO_2 emissions limits will be met.

To assure the public of the integrity of the system, power plants must install continuous emissions monitors (CEM) and regularly report their actual emissions to the U.S. Environmental Protection Agency (EPA). Extensive regulatory documentation and guidelines have been prepared to assist utilities in complying with the Clean Air Act (e.g., Part 75 (Continuous Emission Monitoring) of the Clean Air Act, and Acid Rain CEMS Program Submission Instructions and Monitoring Plan Forms (U.S. EPA 1995a). The Acid Rain Program regulations require all affected utility units to continuously measure, record and report SO_2, NO_x, volumetric flow data, and CO_2 emissions. To ensure that the continuous emissions monitoring systems and fuel flow meters are performing at an acceptable level and providing quality data, the utility company must submit a monitoring plan and certification test data for acid rain CEM certification. EPA's Acid Rain Division must certify all CEMS and fuel flow meters systems. Finally, the utility must submit quarterly reports.

By capturing compliance data, EPA is able to identify non-complying facilities. If companies violate their emission limits, firms forfeit allowances to cover the excess emissions and pay automatic fines at several times the estimated average cost of compliance. Utilities can demonstrate compliance with decreasing SO_2 emissions limits by purchasing allowances from other utilities, banking extra internally created allowances for future use, switching from high-sulfur coal to low-sulfur coal or natural gas, installing scrubbers, shifting some electricity production from dirtier plants to cleaner ones, and encouraging more efficient electricity use by customers.

The ability to continuously monitor emissions and share these data with regulators makes it easier for utilities to make sure they are complying with the law and for EPA and state regulators to detect noncompliance. In addition, large penalties deter noncompliance.

2.2.3. EPA's Conservation Verification Protocols

The U.S. Environmental Protection Agency (EPA) developed the Conservation Verification Protocols (CVP) as part of its mission to implement the Acid Rain Program authorized by Title IV Of the Clean Air Act Amendments of 1990 (EPA 1995b and 1996; Meier and Solomon 1995; Willems et al. 1993).[1] The CVP has two purposes: (1) to provide a basis for verifying energy savings that would entitle utilities to "bonus" allowances under the Act; and (2) to establish a model that provides guidance to utilities and state regulators in what the EPA believes to be appropriate monitoring and evaluation practice. The CVP provides general guidelines for verifying energy savings rather than specifying the verification procedure for each kind of technology, offering utilities the maximum amount of flexibility (Meier and Solomon 1995). Since no specific measurement technology is required, a utility can use whatever will achieve the verification requirements at the lowest cost.

The CVP strongly encourages metering, customer surveys, and billing data analysis over the simple engineering algorithms that typically form the basis for initial program savings estimates (and that are sometimes accepted by public utility commissions). The CVP is designed to be rigorous without being burdensome on the utility or the regulator.

The CVP allows for two general savings paths to earn credit for conservation programs: Monitored Energy Use, or Stipulated Savings. The Monitored Energy Use Path is the preferred verification approach, and its goal is to measure energy use in such a way as to infer net energy savings, i.e., the savings attributable to the utility conservation program. The Stipulated Savings Path includes procedures for estimating savings, as well as simple equations and standard values for estimating stipulated energy savings from a limited number of conservation measures for which expected energy savings are well understood. This path also includes criteria for developing program-specific engineering estimates that may be used by a utility in limited cases. In some cases, utilities may develop their own engineering estimates. The rationale for the Stipulated Savings approach is that the performance of some measures is well understood and may not be cost-effective to monitor. The list of measures with stipulated savings reduces the monitoring and verification burden and allows utilities to focus on programs where impacts are less predictable.

---

[1] Title IV of the Clean Air Act sets as a goal the two-phased reduction of SO_X emissions by 10 million tons below 1980 levels. Phase I began in 1995 and affected 100 mostly coal-burning plants in 21 eastern and midwestern states. Phase II, which begins in 2000, tightens emissions on these units and also sets restrictions on smaller, cleaner plants. To help attain the goal of reduced emissions, the Acid Rain Program uses a market-based system of allowances, each of which is the equivalent of 1 ton of SO_X emissions. As part of the Acid Rain Program, Congress also created the Energy Conservation and Renewable Energy Reserve (CRER) — a bonus pool of 300,000 allowances to reward new (as of January 1, 1992) utility initiatives in conservation and renewable energy. The CVPs provide a basis, although not the only one, for allocating the allowances in the CRER.

Finally, the CVP includes guidelines for verifying the persistence of energy savings from conservation measures. There are several options for estimating subsequent-year savings; in every case, however, they rely on the first-year estimate (Meier and Solomon 1995).

2.2.4. Dutch reporting and monitoring guidelines for long term agreements

As part of energy-efficiency policy, long term agreements (LTAs) on energy efficiency have been made for industrial and other sectors since 1992 in the Netherlands (Ministry of Economic Affairs 1997; Nuijen 1997). The LTAs are one of the instruments applied by the Ministry of Economic Affairs to improve energy efficiency beyond existing trends without resorting to new regulations. In these LTAs, business sectors agree to improve the energy efficiency in their primary processes over a range of years, to meet a set goal in the year 2000.

A quantified energy conservation target for the sector as a whole is set in the LTAs, and the means by which the target can be achieved are described in a long-range plan for the entire sector. This allows individual companies within the sector to determine their own targets to achieve the sectoral target. The LTAs are therefore seen as flexible instruments that are able to recognize the diversity of different sectors. The LTAs are signed by the industry association, the Ministry of Economic Affairs, and the supporting energy agency (Novem). Individual companies express their participation by accession letters.

The LTA includes commitments for individual companies, such as the preparation and implementation of energy conservation plans and annual monitoring of energy data. In addition to the energy data, the company provides the following data: (1) information on key parameters affecting energy use (e.g., amount of persons, amount of time building is occupied, number of students in school, etc.); (2) energy-efficiency measures installed; and (3) energy-efficiency measures not yet installed but likely to be taken. The Dutch government energy agency (Novem) collects these data and calculates the Energy Efficiency Index (EEI). The EEI is the ratio of energy used in the year in question and the energy use that would have resulted had the same production been made with the energy efficiency in the year of reference (1989). The numerator and the denominator is the amount of energy used divided by production volume (e.g., tons of bulk product or number of bricks) or size of facility (m^2).

Progress with the LTAs is monitored on an annual basis, and annual reports are prepared. The aim is to realize an average improvement of energy efficiency of 20% in industry, 25-30% in public utilities and 23% in agriculture in comparison with the 1989 level by the year 2000. This relates to energy consumption per physical unit of product.

2.3. Summary

The existing GHG and non-GHG protocols and guidelines contain many provisions that should be useful for the development of MERV guidelines for climate change mitigation projects. In Tables 1 and 2, we highlight the key features of these guidelines as possible models for MERV guidelines. We discuss several of these protocols in more detail in the next three chapters. Most of these existing guidelines refer to other documentation for addressing MERV issues (e.g., sampling, impact analysis of energy savings, etc.) and are flexible in the type and amount of information that is requested from project developers.

Table 1. Key Features of Existing GHG Protocols and Guidelines

Protocol/Guideline	Key Features
USIJI's project proposal guidelines	For project proposal preparation. Comprehensive request for information on GHG and non-GHG impacts, including methodologies, calculations, assumptions, references and key uncertainties. External verification required. Evaluation Panel plays significant role in evaluating project submissions.
SBSTA's uniform reporting format guidelines	For reporting on projects. Based on USIJI guidelines. Requests information on environment, social/cultural, and economic impacts, and on technical difficulties or other obstacles encountered.
WBCSD's project proposal guidelines	For project proposal preparation. Requests information on monitoring, data collection procedures, and external verification. Asks for contingency plan, and discussion of key uncertainties and leakage issues.
World Bank's monitoring & evaluation guidelines	For monitoring and evaluating projects. Provides detailed information for describing institutional impacts and issues. Contains basic framework for addressing methodological issues dealing with monitoring and evaluation.
DOE's voluntary reporting guidelines	For reporting on projects. Offers guidance on recording GHG emissions and GHG reductions. Some guidance on joint reporting and certification. Requests information on direct and indirect emissions .
Winrock's carbon monitoring guidelines	For monitoring projects. Detailed guide to monitoring carbon sequestration, and provides a field-tested system for monitoring net changes in carbon in carbon pools.
SGS Forestry's carbon offset guidelines	For all MERV activities. First international third-party verification service of forestry-based carbon offset projects. Assesses methodologies and verifies emission reduction projections, based on a surveillance program. Requests information on additionality, externalities, and capacity issues. Uses a carbon quantification model.

Table 2. Key Features of Existing Non-GHG Protocols and Guidelines

Protocol/Guideline	Key Features
DOE's energy M&V guidelines	For evaluation of projects. Emphasizes baseline conditions, quality of measure installation, and measured savings. Provides several measurement and verification options for user flexibility.
EPA's acid rain monitoring protocols	For monitoring and reporting on projects. Continuous monitoring of emissions. Penalties for noncompliance.
EPA's conservation and verification protocols	General guidelines for verifying energy savings, allowing for user flexibility. Two general savings paths (monitored and stipulated). Options for estimating persistence of energy savings.
Dutch reporting and monitoring guidelines	For monitoring and reporting. Targets set, but maximizes user flexibility in meeting targets: no prescribed monitoring methodology.

CHAPTER 3. GENERIC MERV ISSUES

In this chapter, we first present the key principles that should guide the development of MERV guidelines and protocols. We then discuss generic issues that MERV guidelines should address for energy-efficiency, renewable energy, and forestry projects: establishing a credible baseline, net GHG and other impacts, precision of measurement, persistence of impacts, multiple reporting, verification of GHG reductions, uncertainty and risk, institutional issues, and the cost of MERV.

3.1. MERV Principles

Any proposed MERV guidelines should reflect the following principles: they should be consistent, technically sound, readily verifiable, objective, simple, relevant, transparent, and cost-effective (Table 3). If guidelines are not designed with these principles in mind, then their use and application will be limited and opportunities for providing false and misleading information will go unchecked. In reality, tradeoffs will have to be made for some of these criteria: e.g., simplicity versus the technical soundness of a guideline. Because of concerns about high transaction costs in responding to MERV guidelines (e.g., Andrasko et al. 1996; Dudek and Weiner 1996; Embree 1994; Heister 1996), the guidelines cannot be too comprehensive and burdensome; however, the basic principles should be used to guide the development of the protocols.

3.2. MERV Impacts and Responsibilities

Based on our review of the literature and discussions with experts in the field, we believe that the MERV guidelines should address the following types of impacts: net reduction in GHG emissions; other environmental impacts; and economic and social impacts. We discuss these impacts and highlight examples of their use as prescribed in existing protocols.

We include a broad array of impacts for three reasons. First, a diverse group of stakeholders (e.g., government officials, project managers, non-profit organizations, community groups, project participants, and international policymakers) are interested in, or involved in, climate change mitigation projects and are concerned about their multiple impacts. Second, the persistence of GHG reductions and the sustainability of climate change mitigation projects depend on individuals and local organizations that help support a project during its lifetime. Both direct and indirect project benefits will influence the motivation and commitment of project participants. Hence, focusing only on GHG impacts would present a misleading picture of what is needed in making a project successful or making its GHG benefits sustainable. Third, it is premature to peremptorily decide which impacts are more important than others. Each project will need to decide the appropriate allocation of resources for addressing project impacts. For the purposes of this report, we believe the guidelines should cover all impacts.

Table 3. MERV Principles

1. **Consistent:** the MERV guidelines need to be internally consistent, so that what is required for reporting within a sector, for example, does not conflict with what is required for monitoring (or vice versa). In addition, there must be consistency in the use of measurement techniques and methods, for example, between different sites, stands, and inventory periods. And there must be a parallel treatment of GHG flows across sectors.

2. **Technically sound:** the MERV guidelines need to be based on established principles and methodologies that have been used by other professional organizations, accepted by technical authorities, or reviewed by a technical advisory panel.

3. **Readily verifiable:** monitoring and reporting need to be readily verifiable, so that someone can: (a) review the data or documentation (e.g., procedures, methodologies, analyses, reports); (b) inspect or calibrate measurement and analytical tools; and (c) repeat sampling and measurements.

4. **Objective:** the MERV guidelines need to be "objective" (i.e., independent) so that a particular position or perspective is not biasing the collection, analysis, or reporting of results.

5. **Simple:** the MERV guidelines need to be simple and understandable to most audiences. Typically, tradeoffs need to be made between simplicity and usefulness: if the guidelines are too simple, they may not be used because they lack detailed information for implementation; if the guidelines are too complex, they may not be used because they are too confusing or burdensome for implementation.

6. **Relevant:** the MERV guidelines need to cover information that is necessary for reporting, monitoring, evaluation and verification. Unnecessary data should not be collected.

7. **Transparent:** the MERV guidelines need to emphasize the importance of making the assumptions and methods of the analysis transparent.

8. **Cost-effective:** the MERV guidelines need to be cost-effective in their implementation. The cost of data collection, analysis, and reporting, for example, should not be too high to create a burden to the user.

We realize that it will be very difficult and expensive for one organization to conduct MERV activities on all of these impacts. As discussed in Section 3.4, we expect that multiple organizations will be involved in the MERV process and that the financial burden of these activities will be shared by many groups. For example, in the case of joint implementation projects, we expect both investor and host countries to collaborate and share the costs on MERV activities. In addition, we expect each stakeholder to assess the transaction costs of complying with the MERV guidelines. As a result, not all of the issues proposed for inclusion in the guidelines may be addressed by the organizations responsible for monitoring, evaluation, reporting or verification.

3.2.1. GHG emissions impacts

The GHG-related protocols are primarily devoted to the proper reporting of GHG emission reductions. This may include: physical quantities of individual gases involved, tons of carbon equivalent, or total amount of carbon.

In DOE's Voluntary Reporting Program, the first reporting cycle (1995) focused on the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and halogenated substances (e.g., CFCs, HCFCs, PFCs) (DOE 1994a and 1994b). After the second reporting cycle (1996), other radiatively enhancing gases can be reported: e.g., nitrogen oxides (NO_x), nonmethane volatile organic compounds (NMVOCs), and carbon monoxide (CO). Emissions and emission reductions are reported in metric tons of each gas emitted. Reporters can calculate the various effects of different gases on climate by using a common index, such as the equivalent effect in tons of carbon dioxide; information about the IPCC's Global Warming Potential (GWP) and GWPs for the types of gases covered by DOE's reporting system are provided in DOE's documentation.

The data reported on DOE's Form EIA-1605 are grouped by: greenhouse gas; whether the reported emissions and reductions are direct or indirect (see Section 2.2.1); whether the source of the emissions and reductions is stationary combustion, transportation, or some other source; and whether the source of the emissions and reductions is domestic or foreign. The period covered for reporting emissions is divided into the baseline years (1987 to 1990) and annual report years (1990 to 1994). And the reporting is done at the project and entity levels.

The USIJI guidelines request that estimates of GHG emissions reduction and sequestration be provided in a transparent manner and that they be estimated for each GHG in kilograms or metric tons (USIJI 1996). The gases that apply are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) perfluorocarbons (PFCs), other halogenated compounds, and, optional but desired if available, precursors of tropospheric ozone (O_3), including nonmethane volatile organic compounds (NMVOCs) and nitrogen oxides (NO_X).

The SBSTA's uniform reporting format guidelines request projected emission reductions for carbon dioxide, methane, and nitrous oxide.

The World Bank relies on emission factors to estimate GHG emission reductions (World Bank 1994a; see also IPCC 1995). The emission factors represent the basic conversion between energy consumption and generation of greenhouse gases. These factors are usually expressed in mass of emitted gas per unit of energy input (g/GJ) or sometimes in mass of gas per mass of fuel (g/kg or g/t). As noted in The World Bank Report:

> "Emission factors are best obtained by actual measurements from the particular equipment in question, either through continuous or spot monitoring; if such data is not available, published emissions factors can be used." (World Bank 1994a)

The World Bank provides some basic guidelines for selecting a method to acquire emissions factors. The World Bank prefers the use of physical quantities of individual gases since it is:

> ". . . unambiguous and facilitates the estimation of non-greenhouse environmental effects, such as local air pollution attributable to CO or NO_X. Carbon dioxide-equivalent can be convenient shorthand for summarizing total GHG impacts by converting the physical quantities of each gas to the amount of carbon dioxide that would have the same radiative forcing effect. It is also useful for comparing the relative effects of different gases. However, it is not always possible to specify the actual GHG impact of a particular project. As will be seen with biomass production projects, carbon is stored as part of the complex sugars found in biomass. The GHG impact of this storage depends on the fate of the biomass: if it is burned, it will produce a certain mix of greenhouse gases; if it decomposes, it will produce a different mix with a different radiative forcing effect. Such projects cannot be evaluated on the basis of carbon content alone." (World Bank 1994a)

For forestry projects, MacDicken provides a detailed methodology for calculating the amount of carbon accumulated in forest plantations, managed natural forests and agroforestry land uses, as well as a monitoring system for assessing changes in four main carbon pools (above-ground biomass, below-ground biomass, soils and standing litter crop — see Section 5.6) (MacDicken 1996).

SGS Forestry's Carbon Offset Verification Service provides a detailed workbook on presenting similar information for forestry projects, including the rates of change of carbon pools (e.g., trees, other vegetation, necromass, soil, and wood products) and net carbon flows (EcoSecurities 1997).

3.2.2. Other environmental impacts

Climate change mitigation projects have widespread and diverse environmental impacts that go beyond GHG impacts. The environmental benefits associated with climate change mitigation projects can be just as important as the global warming benefits. For example, land use projects can help protect threatened forests, restore watersheds and riparian habitat, preserve vital biodiversity resources, promote rural economic development, and increase agricultural productivity.

Accordingly, we believe, as do most existing GHG protocols and guidelines (see Table 11), that the MERV guidelines should contain information on environmental impacts in addition to GHG impacts, including changes in emissions of other gases and particulates, biodiversity, soil conservation, watershed management, sustainable land use, water pollution reduction, and indoor air quality. Some of these impacts can be monetized for cost-benefit analysis, while other impacts cannot be monetized and should be considered on their own merits (e.g., protection of land as a wildlife refuge). This information will be useful for better describing the stream of environmental services and benefits of a project, in order to attract additional investment and to characterize the project's chances of maintaining reduced GHG emissions over time. This information will, hopefully, also help in mitigating any potentially negative environmental impacts and encouraging positive environmental benefits. In some countries (e.g., Brazil and India), an environmental impact assessment is required for projects above a certain size. For those countries not requiring a formal environmental impact statement, it is expected that experts will be needed to identify major environmental impacts and to evaluate how the climate change mitigation projects might mitigate negative environmental impacts in the future.

A policy issue related to the requirement of an environmental impact statement concerns the application of a country's laws and guidelines: e.g., where an investor country funds a project in a host country, do the laws of the investor country apply? or the host country's? or both? And what happens if the laws from the two countries conflict? We do not expect the guidelines to address this issue, but raise the issue for policymakers.

All of the countries involved in joint implementation activities are concerned with environmental impacts; they all have adopted the same basic criteria approved by the Conference of the Parties to the UNFCCC in making sure that all of their projects are compatible with and supportive of national environmental and developmental priorities and strategies and contribute to cost-effectiveness in achieving global benefits (see Appendix C). Costa Rica delineated several national sustainable development priorities in their list of criteria, including the following: biodiversity conservation; reforestation and forest conservation; sustainable land use; watershed protection; and air and water pollution reduction. Similarly, one of Poland's criteria in project selection is that joint implementation projects "should not lead to increases in other local/regional environmental quality indicators at the expense of achieving reductions in GHG emissions."

The USIJI's guidelines also specifically address environmental impacts:

> "Describe any significant nongreenhouse gas environmental impacts, both positive and negative, that are anticipated as a result of the specific measures to reduce or sequester emissions. If the measures are part of construction of a larger project, please also describe any significant nongreenhouse gas environmental impacts, both positive and negative, that are anticipated as a result of the larger project. Include effects on air, water, soil, human health and biodiversity.
>
> For each significant negative environmental impact described above, discuss any steps that will be taken to mitigate it." (USIJI 1996)

The World Bank notes the importance of environmental (and socioeconomic) issues in evaluating GHG emission reduction projects and has a check list of potential issues for conducting an environmental assessment of climate change mitigation projects (World Bank 1989):

> "The evaluation of GHG impacts is only part of the story, and certainly not the only one upon which the value of a GEF project should be judged. A project may have a demonstration value far beyond the amount of GHG reductions resulting from the project. One purpose of the GEF is to help make the financial and economic benefits of a project outweigh the costs by taking into account global impacts. This implies the existence of benefits other than GHG reduction. A household photovoltaic lighting project may do little to reduce total GHG emissions, but it may have a very positive immediate impact on people's lives. A biomass production project that preserves forests may help biodiversity. While these guidelines make no attempt to assess the non-GHG impacts of a project, such considerations are crucial for overall project assessment." (World Bank 1994a)

Hence, at a minimum, baseline data on key environmental indicators need to be collected. For some projects, a full year of baseline data is desirable to capture the seasonal effects of certain environmental phenomena. Short-term monitoring could be used to provide conservative estimates of environmental impacts, while longer-term data collection is being undertaken. Any negative impacts of the project on local, regional and possibly national air sheds, watersheds, ecosystems and economies should be measured (Andrasko et al. 1996). Opportunities for environmental enhancement should be explored. The extent and quality of available data, key data gaps, and uncertainties associated with estimates should be identified and estimated. The following key issues need to be examined for environmental impacts: what type of monitoring and evaluation is needed, who should do the monitoring and evaluation, how much will monitoring and evaluation cost, and what other inputs (e.g., training) are necessary?

3.2.3. Economic and social impacts

A project's survival is dependent on whether it is economically sound: i.e., the benefits outweigh the costs. Different economic indicators can be used for assessing the economics of climate change mitigation projects: e.g., cost-benefit ratio, net present value, payback levels, rate of return, cost in dollars per ton of carbon, carbon sequestered per hectare, etc. Similarly, these indicators should be calculated from different perspectives: e.g., government, investor, consumer, etc. In addition, the distribution of project benefits and costs need to be evaluated to make sure one population group is not being unduly affected.

Hence, in addition to GHG emissions and environmental impacts, the MERV guidelines should cover the economic and social impacts of the climate change mitigation projects, such as:

- project costs: capital & operating costs, opportunity costs, incremental costs
- cost-effectiveness: based on different indicators and perspectives (see above)
- macro-economic impacts: gross domestic product, jobs created or lost, effects on inflation or interest rates, implications for long-term development, foreign exchange and trade, other economic benefits or drawbacks, displacement of present uses
- equity impacts: differential impacts on income groups or future generations

The DOE Voluntary Reporting Program guidelines and The World Bank guidelines do not specifically address these issues, except in a general manner (see Section 3.2.2). The USIJI guidelines address these issues more directly:

> "Describe the potential positive and negative non-environmental effects of the project, including but not limited to: economic development, cultural and gender effects, sustainability, technology transfer, public participation, and capacity building." (USIJI 1996)

The World Bank has prepared some guidance on this issue in their guidelines on the social assessment of biodiversity conservation projects (World Bank 1994b). The types of questions include: who the key stakeholders are, what project impacts are likely and upon what groups, what key social issues are likely to affect project performance, what the relevant social boundaries and project delivery mechanisms are, and what social conflicts exist and how they can be resolved. To address these questions, evaluators could conduct informal sessions with representatives of affected groups and relevant non-governmental organizations (NGOs).

The need to analyze social factors that influence a project continues throughout the entire life of a project. The evaluation of the social dimensions of a project is called a social analysis or social impact assessment (Asian Development Bank 1994). The social analysis typically includes an assessment of the benefits to the clientele participating in the project (e.g., does the project meet their needs), their capability to implement the project (e.g., level of knowledge and skill and capabilities of community organizations), and any potential adverse impacts on population groups affected by the project (e.g., involuntary resettlement, loss of livelihood, and price changes).

During the project development stage, projects are approved if they are consistent with the general development objectives of the host country, in terms of social and economic effects. After a project has been implemented, MERV activities should assess whether the project ensured the following (EcoSecurities 1997):

1. The legal and customary land and resource use rights of local communities and indigenous peoples are recognized and honored.

2. The concerns of local communities and indigenous peoples regarding all project operations are actively sought and fully taken into account in planning and implementing these operations.

3. The project is developmentally appropriate or provides positive secondary outputs, according to the following areas of analysis:

    - Long-term income opportunities for local populations
    - Employment rights
    - Appropriate technology transfer
    - Social development
    - Increasing public participation and capacity building
    - Maintaining and fostering local cultures
    - Gender equity
    - Tenure and land use rights
    - Human rights

3.3. Establishing a Credible Baseline

One of the critical questions that needs to be addressed by users of the guidelines is how much of an impact can be attributed to a particular project. In order to conduct this type of calculation, one needs to establish a credible baseline (reference case). Without an appropriate baseline, it is impossible to accurately estimate GHG reductions due to a particular project:

> "The validity of any particular project rests upon the case made that environmental performance — in terms of achieving GHG reductions — exceeds historical precedents, legal requirements, likely future developments, or a combination of the three." (EcoSecurities 1997)

The development of a baseline requires both analysis and negotiation: analysis is needed to define the framework for the baseline, and the baseline is then negotiated by the parties to accomodate the uncertainties inherent in the development of the baseline.

DOE's voluntary reporting guidelines define reference case in two ways ("basic" and "modified"):

> "A basic reference case is the most straightforward. A basic reference case is the reporter's level of emissions at some period in the recent past: for example, the reporter's emissions in the year 1990. This definition is closest to the definitions implicit in the Framework Convention and those used in the Clean Air Act emissions trading scheme. If the reporter's emissions today are less than they were in 1990, then the size of the reporter's reduction is equal to the difference between current emissions and 1990 emissions." (DOE 1996a)

The basic reference case as defined above corresponds to the "reference year" as used in the United Nation's Framework Convention on Climate Change (FCCC, Article 4.2(b)) (UNEP/WMO 1992). In this context, Annex I countries are committed to reducing their emissions of carbon dioxide and other greenhouse gases to 1990 levels, which avoids the need to establish a credible baseline. If all countries agreed to a cap, national baselines would not be needed. Project-specific baselines, however, may still be desirable to estimate the project's cost-effectiveness, for example.

The above basic reference case is most meaningful in the context of emissions for an organization (e.g., utility company) and are ambiguous for specific types of projects (e.g., new construction and reforestation projects). Thus, the second definition of reference case is permitted:

> "A modified reference case is, in effect, a hypothetical case: the notion is that a reporter's emissions would have been higher, if he had not taken certain actions. . . . Modified reference cases always have a degree of uncertainty about them, since it is never possible to be absolutely certain about what would have happened in the absence of a particular action." (DOE 1996a)

In practice, most projects reporting to DOE in the Voluntary Reporting Program used various forms of a modified reference case, and two-thirds of entity-wide reporters (e.g., utilities reporting on multiple projects) also used a modified reference case in DOE's Voluntary Reporting Program (DOE 1996a). Moreover, the modified reference case as defined above corresponds to the "reference case" used by non-Annex I countries in determining the full incremental costs of implementing measures covered under the FCCC (Article 4.3) (UNEP/WMO 1992). In the rest of this paper, the reference case corresponds to the modified reference case (rather than reference year).

The USIJI guidelines request each applicant to develop a baseline for emissions or sequestration processes without the proposed measures. The baseline should describe the existing technology or practices at the facility or site and associated sources and sinks of GHG emissions (USIJI 1996). The emissions from sources and sequestration of greenhouse gases by sinks are to be estimated for a full year before the date of the initiation of the project and for each year after the initiation of the project over the lifetime of the project without the project. The guidelines remind the project proposers that future GHG emission levels may differ from past levels, even in the absence of the project, due to growth, technological changes, input prices, product prices, and other exogenous factors.

The WBCSD proposal guidelines request similar information from project applicants in describing the baseline: external factors influencing GHG emissions over the term of the project, relevant product prices and sales, effects of regulations, regional population projections, and general economic and technological trends (WBCSD 1997).

Finally, SGS Forestry's guidelines require a project baseline that is primarily based on historical trends but may be different in the future due to expected policy or regulatory shifts, economic circumstances, technological diffusion, social and population pressure, and market barriers (EcoSecurities 1997).

The development of a valid baseline is challenging because of the multiple impacts that need to be evaluated (as discussed in the previous section) and because of the different trends that are (and will be) occurring in markets, technologies, policies, and legal requirements.[1] Parties involved in the negotiation of a baseline may want to change the baseline to reflect changes over time.

3.3.1 Monitoring domain revisited

Developing a credible baseline is difficult, but not insurmountable, because of the complexities in delineating the appropriate monitoring domain. In Section 1.2.1, we described four key monitoring domain issues that developers of a baseline need to address: (1) the temporal and geographic extent of a project's direct impacts; (2) upstream and downstream coverage of indirect energy impacts and pre- and post-harvest coverage of indirect forestry impacts; (3) national and international leakage; and (4) off-site baseline changes. Some of the existing protocols and guidelines briefly mention these issues, but none of them address all of them.

[1] For example, in the United States, Western Europe, and in several other countries, electric utilities are facing a new era as the energy industry undergoes restructuring. It is premature to describe the new future of the industry. Nevertheless, we expect that there will be more organizations involved in the delivery of energy and energy services, making the determination of a baseline that much more difficult.

USIJI's project proposal guidelines address the first two monitoring domain issues by requesting estimates of emissions and sequestration of GHGs to include any:

> "... significant anticipated indirect or secondary greenhouse gas emissions effects of the project, such as effects on a neighboring site, greenhouse gas emissions from project construction, activity shifting and other potential effects." (USIJI 1996)

WBCSD's proposal guidelines specifically address the leakage issue by requesting each applicant to identify potential sources of leakage and describe the steps that will be taken to reduce the risks of potential leakage, or to ensure that the benefits of the proposed project would not be lost or reversed in the future due to leakage (WBCSD 1997).

SGS Forestry's guidelines address the leakage issue by requesting each project developer to: describe all of the situations where leakage might occur, identify which of these situations are most likely to occur and why they are likely to occur, indicate how much of the GHG savings could be lost by leakage, and identify the manner in which the project would act to minimize the likeliest forms of GHG leakage (EcoSecurities 1997).

In DOE's Voluntary Reporting Program, the guidelines discuss the second monitoring domain issue indirectly, when they discuss "direct" and "indirect" emissions: direct emissions result from fuel combustion or other processes that release greenhouse gases on-site, while indirect emissions occur when activities cause emissions to be generated elsewhere (see Section 2.1.1).

What should the optimal system boundary be for the monitoring domain? Is there an easy rule of thumb to use for defining the optimal system boundary, keeping in mind the principles discussed at the beginning of this chapter? Or must one monitor a country's entire national energy system for all energy-efficiency projects, or monitor timber production in several key countries for all forestry preservation projects? As we discuss later in Sections 4.2 and 5.3.1, leakage may be identifiable, so the appropriate monitoring domain can be delineated. Also, in many cases leakage may be avoidable in project design.

3.3.2 Net GHG and other impacts

Project impacts need to be seen as net impacts (also referred to as "additionality") to reflect the differences from what most likely would have happened without the project (the baseline, or modified reference case).[1] Existing protocols vary in addressing net impacts. There is no mention of net energy

[1] Most evaluations will focus on the direct impacts of a project on carbon emissions and will not attempt to extrapolate the project findings to a wider area or population. If extrapolation is attempted, one must pay close attention to the types of participants in a project, to see if they are representative of

savings in DOE's Voluntary Reporting Program, while The World Bank recommends that evaluations should account for these issues.

EPA's Conservation Verification Protocol permits utilities to use "net-to-gross" factors to convert the calculated "gross energy savings" to "net energy savings."[1] For measures specified in the Stipulated Savings path, a table of net-to-gross factors is provided, based upon experience with utility conservation programs. If a utility develops its own net-to-gross factor, supporting documentation for the factor must be attached to the verification form (e.g., market research, surveys, and inspections of nonparticipants). If a utility does not do any monitoring nor provide documentation and the measure is not a stipulated measure, then the net energy savings of a measure will be 50% of the first-year savings.

A few guidelines and protocols request more detailed information on net impacts. For example, USIJI guidelines state:

> "Project applicants will need to demonstrate to the satisfaction of the [Evaluation] Panel that the measures undertaken or to be undertaken are above and beyond what would reasonably have been or be likely to occur otherwise. Reductions may be of two types: reductions in greenhouse gas emissions from sources, or sequestration of greenhouse gases through the enhancement of natural biotic sinks. In either case, the reduction or sequestration must be below that established by a credible base or reference case." (USIJI 1996)

Accordingly, project participants in the USIJI program are requested to: describe how their project would overcome barriers to developing or implementing the project, discuss whether any measures in the proposed project were required by existing laws or regulations, and describe prevailing technologies and management practices in the host country (USIJI 1996).

SGS Forestry asserts that additionality is the "crux of the carbon concept" and the "greatest qualitative challenge" for the analyst in most instances (EcoSecurities 1997). No project can claim emission reductions unless project proponents make a reasonable demonstration that the project's practices are "additional" to "business as usual" circumstances (the baseline). Determination of additionality, therefore, requires a clear definition of the baseline and project cases. SGS Forestry's

---

the general population or whether they are unique. For example, when project participation is voluntary, systematic (nonrandom) differences may occur between participants and a comparison group (Vine 1994). A statistical approach for addressing the self-selection problem involves the estimation of both a discrete choice program participation model and a multivariate regression model of energy savings (Violette et al. 1991; Train and Paquette 1995). Accordingly, the guidelines need to specify how self-selection bias was addressed when a project is evaluated.

[1] The "net-to-gross" factor is defined as net savings divided by gross savings. The gross savings are the savings directly attributed to the project and include the savings from all measures and from all participants; net savings are gross savings that are "adjusted" for free riders and free drivers (see below). Multiplying the gross savings by the net-to-gross factor yields net savings.

guidelines recommend that the determination of the baseline be examined by analyzing both historical and future trends. After establishing a baseline, one then needs to determine additionality by evaluating program intent (i.e., was the project initiated with the specific intent of lowering emissions?), emissions additionality (i.e., did specific measures lead to reductions in emissions?), and financial additionality (i.e., did the project rely on new funds or already committed funds?).

Another valuable evaluation technique for measuring net impacts is the comparison of project participants, plots and areas with a comparison (control) group, plots and areas. In some cases, finding a proper comparison group may be very difficult, if not impossible (e.g., new construction, industrial projects, unique forestry preservation projects). In Sections 4.4 and 5.7, we return to the use of comparison groups in measuring net impacts in the energy and forestry sectors, respectively.

Apart from the obvious uncertainty about what would have happened without the project, the actual determination of net impacts is elusive for additional reasons, such as free riders, project spillover, and market transformation. While very few of the existing protocols and guidelines address these issues, we believe that MERV protocols and guidelines should cover these reasons where indicated. For example, when evaluating the GHG reduction impacts of energy-efficiency projects, it is possible that the reductions in GHG emissions were undertaken by participants who would have installed the same measures if there had been no project (Vine 1994). These participants are called “free riders.” It is important to estimate free ridership to estimate the real impact of the project on carbon reductions. Free ridership can be estimated by contrasting changes in GHG emissions among participants with that of a comparison group, or ascertained from surveys.

When measuring the carbon reduction impacts of projects, it is also possible that the actual reductions in carbon emissions are greater than measured because of changes in the behavior of project participants that are not directly related to the project or to changes in the behavior of other individuals not participating in the project (i.e., nonparticipants). These indirect impacts stemming from an energy-efficiency project are commonly referred to as “project spillover”. Spillover effects can occur through a variety of channels including: (1) an individual hearing about a project measure from a participant and deciding to pursue it on his or her own (“free drivers”); (2) project participants that undertake additional, but unaided, energy-efficiency and forestry actions based on positive experience with the project; (3) manufacturers changing the efficiency of their products, or retailers and wholesalers changing the composition of their inventories to reflect the demand for more efficient goods created through the project; (4) governments adopting new building codes, appliance standards, or forestry preservation projects because of improvements to appliances resulting from one or more energy efficiency projects or because of the success of forestry preservation projects being conducted by private companies;

or (5) technology transfer efforts by project participants which help reduce market barriers throughout a region or country.

Project spillover is related to the more general concept of "market transformation," defined as: "the reduction in market barriers due to a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced or changed" (Eto et al. 1996). Market transformation has emerged as a central policy objective for future publicly funded energy-efficiency projects in the United States, but the evaluation of such projects is still in its infancy. Greater focus is needed on assessing markets, evaluating market effects, and evaluating reductions in market barriers. The guidelines need to specify how the issue of market transformation will be addressed when estimating GHG reductions.

3.4. Precision of Measurement

Because of the difficulties and uncertainties in estimating energy savings and carbon sequestration, one needs to know the level of precision and confidence levels associated with the estimated savings or sequestration. The guidelines should recommend the level of precision that is required or should provide options for different levels of precision, so that project developers can decide the level of accuracy based on costs and the needs of policymakers. The guidelines would not necessarily guarantee precision of measurement for individual projects, but they could avoid systematic miscalculations. Investors in future projects could decide the appropriate balance between the precision of measurement (or rather the research costs for higher precision) against the risk resulting from larger quantification errors (Heister 1996).

Precision refers to the degree of agreement in a series of measurements of impact. Confidence refers to the probability that the actual impacts of a program can be expected to fall between an upper and lower bound. Thus, where statistical methods are used, the accuracy of estimates of project impacts are generally reported using a measure of precision usually expressed in percentage terms at a given level of confidence (expressed as a percent probability) (Raab and Violette 1994). The degree of credibility that may be attached to results is expressed by the level of statistical confidence (e.g., 90% confidence). This is in contrast to the precision of the estimate, which is gauged by the width of the confidence interval itself. For example, project sponsors may want to report their results by saying: "We are 90% confident that we have reduced carbon emissions by 1,000 tons, plus or minus 400 tons" or "We are 80% confident that we have reduced carbon emissions by 1,000 tons, plus or minus 100 tons."

Confidence and precision are competing ends when budgets are fixed. For a fixed sample size and variance, a reduction in the interval width, causing greater precision, can be achieved only at the expense of reducing the level of confidence, and vice versa. The only way to increase both confidence and precision is to collect a larger sample, but there are costs associated with this. Thus, precision levels (and our confidence in savings results) are typically driven by budgets, not *a priori* accuracy criteria. And the budgets will affect the type of evaluation methods (e.g., econometric methods based on whole-premise billing data, or metering methods utilizing information on specific equipment installed) used to estimate energy savings (and vice versa), also affecting the uncertainty of the evaluation results and project cost-effectiveness. Different methods are subject to different uncertainties that will result in different estimates of precision. For example, some methods (e.g., multivariate regression) have relatively strict assumptions (e.g., normality and little correlation among independent variables).

Most of the existing protocols and guidelines do not discuss precision and confidence levels. In EPA's Conservation Verification Protocols (CVP), the objective of the CVP is to award allowances for savings that occur with reasonable certainty (EPA 1995b and 1996; Meier and Solomon 1995). The CVP requires that the savings are expressed in terms of the utility's confidence that the true savings are equal to, or greater than, those for which it applied. The CVP uses a 75% level of confidence using a one-tailed test (no specific precision level is targeted):[1] the reporting entity must be reasonably confident (at the 75% level) that the minimum level of energy savings has been achieved. Thus, EPA considers a one-tailed test appropriate for most DSM applications because the real concern is not that there is too much savings, but rather that there is too little savings for the project to be cost-effective. Emphasis is thus placed on the lower bound only.

Sampling will be needed for measuring the impacts of energy and forestry projects in order to reduce MERV costs while meeting certain confidence levels. Precision levels have a direct effect on monitoring costs, since the sample sizes need to be chosen to obtain the desired level of precision. This can be complicated for carbon inventories:

> "Carbon inventory is more complicated than traditional forest inventory in that each carbon pool may have a different variance. . . . So while the standard error of the mean for above-ground biomass may be 20% of the mean, if the same sample sizes are used for each carbon pool, the standard error for soil carbon may be 40%, and that for root biomass may be 80% or more." (MacDicken 1996)

---

[1] In a "two-tailed" test, the confidence level indicates the probability that the actual impact falls between an upper and lower bound: e.g., there is an 80% probability that the actual impacts of a program will fall between 900 kWh and 1,100 kWh. In a "one-tailed" test, the confidence level indicates the probability that the actual impacts exceeds a given threshold: e.g., there is a 10% probability that actual impacts fall below 900 kWh, or there is a 90% probability that actual impacts exceed 900 kWh.

Winrock's carbon monitoring guidelines have a form designed to record instructions from the inventory sponsor regarding the desired levels of precision (MacDicken 1996). The sponsor can choose one or more options for addressing precision: general level of precision; specific confidence limits (%); optimum precision for fixed-cost; and cost based on precision. If a general level of precision is specified, the sponsor needs to record the detailed specifications for modeling versus field data collection, cost limits from sponsors, and overall desire for precision (e.g., basic, moderate, high).

SGS Forestry's guidelines require that project developers include an estimate of variance, confidence intervals or standard error for each mean calculated in the analysis of carbon pools and flows that were measured or considered in the calculation of carbon sequestration benefits (EcoSecurities 1997). While the guidelines acknowledge the fact that a universally accepted level of precision for estimates of carbon benefits does not currently exist, they suggest that a reasonable target for the precision of a project's carbon benefit is a standard error of 20-30% of the mean.

Another option to consider is the development of measurement standards, defined as the maximum allowable nonsampling error in measurements (see MacDicken 1997). Measurements that exceed these standards would be considered unacceptable.

A balance needs to be struck between the costs of assessing GHG reductions and the precision of measurement (Embree 1994; Heister 1996). For example, in certain cases, a cheaper solution to increasing the level of accuracy of measurements is to adjust the carbon claims discounting the standard error of measurements. One could use the lower range of the standard error of the mean for estimates of reductions of emissions: e.g., if the calculation of emissions is reported at 100 t carbon/hectare ± 15%, then one could report 85 t carbon/hectare (personal communication from Pedro Moura Costa, EcoSecurities Ltd., August 17, 1997). We return to the tradeoff between costs and accuracy in Section 3.11.

3.5. MERV Frequency

Most of the existing protocols and guidelines require annual reporting (that includes monitoring and verification activities), but do not specify the frequency and duration for the other MERV activities. They typically ask the project developers for a schedule for monitoring and verification. At a minimum, MERV frequency will most likely be linked to the schedule of payments for carbon credits.

The frequency of monitoring, evaluation, reporting, and verification will also depend on the variables being examined. For example, monitoring of litter might be done in the first year of a forestry project and then once every five years, while the monitoring of the end uses of wood might be done annually

(Table 4). Also, within each activity, the duration and frequency might vary by method: e.g., hourly end-use monitoring conducted for a two-week period, or short-term monitoring of lighting energy use for five-minute periods. Finally, it is important to note that the monitoring period may last longer than the project period: for example, a project to install compact fluoresct lamps may last 3 years, but electricity savings from those lamps will continue beyond the project period.

If the frequency of MERV is long, then one needs to consider the possible impact of seasonality as a source of variation (MacDicken 1996). For example, periodic inventories of carbon are likely to be infrequent and cannot account for seasonal fluctuations in the size of carbon pools. Because inventories measure carbon at just one point in time in the seasonal cycle (usually, the dry season), it is crucial to carefully consider the seasonal timing of the inventory before any other planning. To eliminate seasonality as a source of variation in inventory results, subsequent inventories in future years need to be scheduled for the same season as the first inventory, preferably in the same month (MacDicken 1996).

Table 4. Monitoring of Forest Mitigation Projects

Parameters	Unit	Periodicity of Measurement
Soil C at different depth	t C/ha	- Baseline - Once in 2 or 3 years - At the end of project
Litter / slash	t/ha	- Baseline - once in 5 years
Standing tree biomass - above ground`	t of wood/ha	- Baseline - Mid-rotation - End of rotation
Annual C uptake	t of wood/yr	- Annually or periodically
Extraction of wood	t of wood/ha	- Annually - End of rotation
End uses of wood	t of wood/ha	- Annually - End of rotation
Soil and litter decomposition rates	t/ha/yr	- Annually
Root biomass (below ground) accumulation	t of root biomass density/ha	-Baseline - End of rotation

Source: Ravindranath and Bhat (1997)

3.6. Persistence (Sustainability) of Impacts

The sustainability of climate change mitigation projects is critical if the impacts from these projects are to persist. Until recently, the persistence of energy savings was assumed to be relatively constant, and most analyses of persistence relied on engineering estimates of measure life (Vine 1994). For example, most planners assumed that knowing the "physical life" of a measure installed was sufficient to determine persistence: i.e., first-year savings continued for the life of the measure (e.g., a compact fluorescent lamp would last 8 years). Recently, this assumption has been challenged as the issue of persistence has gained more prominence in the evaluation of energy efficiency projects. In fact, the limited empirical research conducted so far raises questions about the validity of using manufacturer's claims for physical measure lives as a basis for projecting persistence (Petersen 1990; Hickman and Steele 1991; Skumatz et al. 1991).

The reliance on technical or average service lifetime, therefore, may overestimate savings from energy-efficiency measures, particularly in the commercial and industrial sectors where renovations and remodels occur frequently and where removal or deactivation of energy conservation measures occurs often (Petersen 1990; Hickman and Steele 1991; Skumatz et al. 1991). In addition, certain building types appear to be more susceptible to frequent remodeling and turnover: e.g., office, retail, restaurant, and warehouse sectors. Another finding affecting persistence of energy savings is that, typically, certain measures in the residential sector are prone to removal by the occupants: e.g., low-flow showerheads, compact fluorescent bulbs, and door weatherstrips (Synergic Resources Corporation 1992).

The issue of persistence is also very relevant for the forestry sector where projects are subject to instantaneous loss from fire or shifting cultivators or harvest, and to longer term loss as biomass decays or when harvested forest products are burned or discarded. The sustainability of carbon sequestration is problematic and needs to be evaluated and verified over time. Given the great uncertainty regarding the fate of wood products and the entire forest, it may be best to refer to the impacts of carbon mitigation projects with units such as "tons of carbon per hectare per year" rather than "tons of carbon per hectare" (Moura Costa 1996). The ton-year unit is useful for comparing carbon benefits of mitigation projects whose effects may differ over time. For example, a forestry project may initially sequester only small amounts of carbon while storing larger amounts in later years; in contrast, an energy-efficiency project may avoid a consistent amount of emissions during its shorter duration. Converting these amounts to ton-years may be viewed as allowing more consistent comparisons of project benefits, however, this will make MERV activities that much more expensive.

The persistence of the impacts from climate change mitigation projects is an issue that is recognized in some of the existing protocols and guidelines. For example, the USIJI's guidelines request each project developer to:

> "Discuss factors that could cause the anticipated greenhouse gas emissions reductions and/or sequestration to be lost or reversed in future years. . . . Identify the steps being taken to reduce the risks ... or to insure [sic] that the effects of the proposed measures will not be lost or reversed in the future. Specify the parties responsible for carrying out these steps." (USIJI 1996)

Other guidelines address this issue by requesting information on the institutional capabilities and support for implementing the project over the project's lifetime (see Section 3.10), or on the risks and uncertainties of a project (see Section 3.9). Because forestry projects may take substantially longer to implement than energy-efficiency projects, the institutional, community, technical and contractual conditions likely to encourage persistence are of utmost concern. Having MERV guidelines to monitor the persistence of GHG impacts will also send a signal to project developers that they should design projects addressing the factors affecting persistence .

Several approaches for monitoring persistence have been proposed. EPA's CVP encourages monitoring over the life of the measure, but gives credit for less stringent verification. Three options are available for verifying subsequent-year energy savings: monitoring, inspection and a default (Meier and Solomon 1995). In the monitoring option, a utility can obtain credit for a greater fraction of the savings and for a longer period: biennial verification in subsequent years 1 and 3 (including inspection) is required, and savings for the remainder of physical lifetimes are the average of the last two measurements. The monitoring option requires a 75% confidence in subsequent-year savings (like in the first year). In contrast, the default option greatly restricts the allowable savings: 50% of first-year savings, and limited to one-half of the measure's lifetime. For the inspection option (confirming that the measures are both present and operating): a utility can obtain credit for 75% of first-year savings for units present and operating for half of physical lifetime (with biennial inspections), or 90% of first-year savings for physical lifetimes of measures that do not require active operation or maintenance (e.g., building shell insulation, pipe insulation and window improvements). For all three options, the gross-to-net conversion factor is calculated once for the first-year savings; the same conversion factor is used in all subsequent years to convert estimates of gross savings. A utility may, if it wishes, re-evaluate the gross-to-net conversion factor in subsequent years, and use updated values.

For energy-efficiency projects, it has been suggested that followup persistence studies be carried out for at least 3 years, and probably for no more than 10 years (Raab and Violette 1994). The time horizon for persistence evaluations will vary by type of measure and project, as well as depend on expected measure lifetimes. For forestry projects, because the sustainability of sequestration may be more problematic, annual persistence studies are probably needed.

It may be desirable to rank or prioritize projects by their persistence or lack of persistence — this will be reflected in "project lifetime." For example, if a project area is likely to undergo serious changes in 10 years, then the carbon emission reductions for that project are limited to that 10-year lifetime. The value of those reduced emissions may be less than for emissions from similar projects that are expected to last longer (e.g., 20 years).

A related, but non-MERV guideline, issue concerns the institutional impacts when the persistence of energy savings or carbon reduction does not occur, resulting in less carbon credits. For example, who is responsible if the carbon credits do not occur as estimated: the project sponsor? the investor? Since it is likely that the investment time period is shorter than project lifetimes, an investor may walk away from a project after 20 years, even though the lifetime of the project is 30 years. Each country should assume responsibility for losses in carbon credits, and these losses should be reflected in the national reporting of emissions.

3.7. Multiple Reporting

Several types of reporting might occur in climate change mitigation projects: (1) impacts of a particular project are reported at the project level and at the program level (where a program consists of two or more projects); (2) impacts of a particular project are reported at the project level and at the entity level (e.g., a utility company reports on the impacts of all of its projects); and (3) impacts of a particular project are reported by two or more organizations as part of a joint venture (partnership) or two or more countries (as part of Activities Implemented Jointly/Joint Implementation). To mitigate the problem of multiple reporting, the guidelines could include the following recommendation:

> "To clarify instances of multiple reporting, project-level reporters are asked whether other entities might be reporting on the same activity and, if so, who. Reporters are also asked about joint-venture partners (if any) for projects, which helps to identify a particular class of multiple reporting with precision." (DOE 1996a)

3.8. Verification of GHG Reductions

If carbon credits become an internationally traded commodity, then verifying the amount of carbon reduced or fixed by projects will become a critical component of any trading system (see Section 1.2.2).

Investors and host countries may have an incentive to overstate the GHG emission reductions from a given project, because it will increase their earnings when excessive credits are granted; as an example, these parties may overstate baseline emissions or understate the project's emissions. We believe that external (third-party) verification processes need to be put in place and not rely on internal verification or audits.

As part of the verification exercise, an overall assessment of the quality and completeness of each of the GHG impact estimates needs to be made by asking the following questions: (1) are the monitoring and evaluation methods well documented and reproducible? (2) have the results been checked against other methods? (3) have results (e.g., monitored data and emission impacts) been compared for reasonableness with outside or independently published estimates? (4) are the sources of emission factors well documented? and (5) have the sources of emission factors been compared with other sources? (IPCC 1995).

USIJI's project proposal guidelines request the applicant to describe the provisions in the project for external verification of GHG reductions. USIJI also requires participants to allow external verification of GHG reductions by an Evaluation Panel, its designee, or a party(ies) named at a later date subject to approval by the Evaluation Panel. Such verification could include third-party inspection of documentation of emissions reductions, or site visits to the project (USIJI 1996).

Similarly, WBCSD's guidelines request project proposers to name the organization(s) responsible for conducting external verification of project activities and records, the frequency of the verification, and the aspects of the project that will be verified (WBCSD 1997).

As described in Section 2.1.7, SGS Forestry's Carbon Offset Verification Service is the first international third-party verification service of forestry-based carbon offset projects (EcoSecurities 1997). The service provides an independent quantification and verification of achieved carbon savings derived from the project, including a surveillance program for assessment of project development and verification of achieved offsets. The surveillance program consists of periodic verification of carbon achievements, concentrating on field implementation and field data gathered by the project's internal monitoring program. This will include field inspections, verification of field books, calculations, field audits, reports, etc. Based on the results of assessments carried out during the surveillance visits, SGS Forestry will issue certificates stating the amount of carbon fixed by the project up to the date of the most recent assessment. The SGS service is designed to provide a greater confidence for carbon offset projects, regulation and transactions, by being an impartial third-party with a uniform evaluation methodology.

Instead of an all-or-nothing verification system, verification teams could adopt a multi-tiered GHG crediting approach, similar to EPA's CVPs, to promote the use of measured data:

> "For example, if, during the first few years, an afforestation project's GHG reduction calculation team does extensive monitoring of the project, the verification team might accept the calculation team's calculated GHG reduction completely, without auditing. If, as the years go by, the calculation team does less monitoring or resorts to spot checks, the verification team might choose to accept only a percentage of the calculation team's calculated GHG reduction. And, if the calculation team stops monitoring the project altogether and bases their calculations on formulaic forecasting, the verification team might accept none or only a very small percentage of the calculated GHG reduction. This crediting mechanism would give the project parties incentive to ensure that long-term monitoring of projects continues. And it gives the project parties the ability to weigh the cost of thorough project monitoring against the benefits of higher GHG reduction credits." (Watt et al. 1995)

Because emission reduction credits will most likely receive detailed scrutiny, it is probably prudent that the credits be differentiated by type of gas (e.g., methane, carbon dioxide, etc.) and by the method used for monitoring and evaluation. As discussed in this report, each method will have a specific level of precision and confidence associated with it. Accordingly, when verifying credits, one should take into account the confidence one has in the data and methods used for estimating the reductions.

Verification should include the following activities: (1) review the data or documentation (e.g., procedures, methodologies, analyses, reports); (2) inspect or calibrate measurement and analytical tools and methods; and (3) repeat sampling and measurements (which may result in the relocation and measurement of different plots).

In conclusion, we believe that third-party verification can enhance and verify the environmental and social benefits of carbon mitigation projects. We revisit this issue when we discuss who should be responsible for verification (Section 3.10.1).

3.9. Uncertainty and Risk

The evaluation of GHG reductions is a risky business, especially with respect to the reliability of the GHG reduction estimates and the credibility of the institutions implementing climate change mitigation projects. Important sources of the first type of uncertainty (i.e., reliability) are: (1) differing interpretations of source and sink categories or other definitions, assumptions, units, etc.; (2) use of simplified representations with averaged values (especially emission factors); (3) inherent uncertainty in the scientific understanding of the basic processes leading to emissions and removals; (4) operation risk (e.g., if the energy-consuming equipment is not used as projected or if the number of trees harvested is increased, then carbon savings will change); and (5) performance risk (IPCC 1995; U.S. AID 1996). The principal performance risks relate to engineering and system design and equipment performance. Engineering and system design risks address the risk that the project is properly engineered to achieve carbon savings and that the design is appropriate to the end user's applications and existing facilities. Equipment performance risk means that the new equipment can perform according to its specifications (U.S. AID 1996).

The credibility of the organization is critical since it affects two types of risk: (1) project development and construction risk, i.e., the project won't be implemented on time or at all, even though funds have been spent on project development; and (2) performance risk (see above). The project developer's experience, warranties, the reputation of equipment manufacturers, the performance history of previous projects, and engineering due diligence are the main methods for evaluating these risks. Furthermore, one should evaluate the political and social conditions that exist that could potentially affect the credibility of the implementing organizations (e.g., political context, stability of parties involved and their interests, potential barriers, existing land tenure system, and the potential for displacement of land pressure to other areas).

These uncertainties vary widely among different greenhouse gases, source categories for each gas, projects (depending on approach, levels of detail, use of default data or project specific data, etc.), and length of projects (e.g., a short-term project might increase reliability if the management of local forests is known to be poor). It is important to provide as thorough an understanding as possible of the uncertainties involved when monitoring, evaluating, reporting and verifying the impacts of climate change mitigation projects. In addition to qualitative analyses of uncertainties, it is useful to express uncertainty quantitatively and systematically in the form of well-developed confidence intervals (IPCC 1995).

The existing protocols and guidelines address uncertainty in varying degrees. For example, USIJI's project proposal guidelines generally examine the issue of uncertainty under the context of persistence and risk reduction (see Section 3.6). WBCSD's project proposal guidelines request a contingency plan from proposers which identifies potential project risks and discusses the contingencies provided within the project estimates to manage the risks (WBCSD 1997). These guidelines also specifically request project proposers to identify and discuss key uncertainties affecting all emission estimates. Furthermore, these guidelines request the proposers to assess the possibility of local or regional political and economic instability and how this may affect project performance. Some of the other guidelines address uncertainty by asking for confidence intervals around their mean estimates (see Section 3.4).

Protocols and guidelines will minimize variability or uncertainty by providing, for example, common definitions of terms, units, and methods, and best practical default estimate procedures and methodologies. Default methods, however, represent a compromise between the level of detail which would be needed to create the most accurate estimates for each project and the input data likely to be available or readily obtainable in most projects. In many cases, the simplest default methods are simplifications with general default values that introduce large uncertainties into a project estimate. Alternative methods to default values should be carefully documented. In fact, whichever methods are used — default methods, more detailed versions of default methods, or entirely different methods — users should determine the ranges of uncertainty in the project impacts (as well as input assumptions).

Thus, it is not enough to solely monitor GHG and other impacts. One also has to monitor the factors that determine project success and sustainability. Impact indicators may not reveal the existence of problems until it is too late to take countermeasures. Some of the project risks are controllable, while others are uncontrollable. The risk elements need to be addressed in the project development stage as well as during the monitoring and evaluation stages. However, arrangements for handling project risks would probably best be left to the contracting parties (e.g., host and investor countries) (Anderson 1995; see Andrasko et al. (1996) for an example of how one joint implementation project took steps to reduce risk).

3.10. Institutional Issues

It is unclear at this time which institutions have the authority and capability of conducting MERV activities: government authorities, auditing companies, self-reporting by project developers or host countries, etc. As discussed in Section 3.10.1, we expect the roles and responsibilities will vary by MERV activity, although some overlap is expected. We expect the division of labor to be a function of available resources and capabilities, the credibility of the person (or organization) in charge of the activity, and the cost of conducting the particular MERV activity.

We believe that local institutions, in particular, should be evaluated during the evaluation of climate change mitigation projects. For example, if local community participants are not involved in the design or implementation of a project, then the sustainability of a project becomes problematic. As discussed in WBCSD's proposal guidelines, the local acceptability of a project is key:

> "The project's acceptability to the relevant governments and stakeholders is critical to overall project success. For example, numerous studies have found that active local participation can enhance the success and durability of a project. " (WBCSD 1997; see Appendix D)

In DOE's Voluntary Reporting Program, the guidelines do not discuss institutional issues; however, in the analysis of the results of the 1995 project data, DOE described some institutional barriers to the evaluation of projects, such as limited expertise in emissions estimation and the limited availability of data within the reporting organization:

> "Organizations rarely collect information on greenhouse gas emissions, and they have no reason to develop corporate expertise in estimating emissions. Reporters must start from scratch in collecting underlying operating data and developing expertise in estimating emissions on the basis of operating data." (DOE 1996a)

The World Bank was cognizant of the potential administrative burden when they developed their guidelines. They noted that to enhance the usefulness of their guidelines, the guidelines were formulated to incorporate the following characteristics, including "ease of use:"

> "... these guidelines are presented to help make it easier for staff to meet their project management obligations. To the extent possible, these guidelines have been developed to coincide with existing project management procedures, and to assist task managers with the early integration of M&E [Monitoring and Evaluation] into projects with minimal effort." (World Bank 1994a)

The World Bank is also cognizant of the political impact of these projects by requiring reporters to describe the institutional baseline of the project in order to answer the question: "Why did things happen as they did?" (World Bank 1994a).[1] In particular, information on organizational capacity and inter-organizational relationships are requested since they are necessary for the eventual evaluation of a Global Environment Facility (GEF) project. Information on institutional capacity covers the credibility, experience and manpower situation in the executing agency, such as: (1) size of staff (field operations, engineering support, planning, finance/administration, etc.) by function; (2) academic qualifications, area of expertise, and years of experience of agency staff; (3) supporting agencies (e.g., public sector agencies, private consultants, or international organizations); and (4) internal structure of the implementing agency.

Furthermore, The World Bank guidelines request information on the relationships among project stakeholders: (1) where the project was conceived; (2) identifiable groups of project advocates or opponents; (3) any political backing for the project; (4) the slice of the potential community of stakeholders; and (5) any efforts that have been made to convince stakeholders of the value of the project.

SGS Forestry's guidelines directly address this issue as part of their carbon offset verification service. Special attention is paid to "capacity issues" as projects have to demonstrate: (1) financial capacity

---

[1] Because the World Bank funds large projects, they are particularly sensitive to the socioeconomic and institutional impacts of their projects in host countries.

(i.e., the organization must demonstrate that it has sufficient financial resources to implement the project throughout its time frame); (2) management capacity (i.e., the organization must demonstrate its capacity to document and implement the project); and (3) infrastructure and technological capacity (i.e., the organization must demonstrate access to appropriate labor pools, technical skills, technologies and techniques and general infrastructure necessary for the implementation and maintenance of the project throughout its time frame) (EcoSecurities 1997).

In sum, the MERV guidelines should cover the administrative, institutional and political impacts of the climate change mitigation projects, such as: (1) administrative burden (e.g., institutional capabilities); and (2) political impacts (e.g., sustained political support, consistency with other public policies).

3.10.1. Roles and responsibilities

Because of the diverse activities involved in the MERV of GHG reductions, we expect that several organizations will be involved at different levels (local, state, regional, national, and international) (Table 5). It is imperative that the roles and responsibilities are clarified as early as possible, so that they are tailored to the appropriate organization; otherwise, delays in the designation will likely lead to delays and disputes later.

Table 5. Primary MERV Responsibilities

	Monitoring	Evaluation	Reporting	Verification
Project developers	✔	✔	✔	
Consultants	✔	✔		✔
Nongovernmental organizations		✔		✔
Governmental agencies			✔	✔
International organizations	✔	✔	✔	✔

One review of pilot Joint Implementation projects suggests that project developers and project parties, who are most closely associated with the project and thus have access to the data and information, should play an instrumental role in the monitoring, evaluation, and reporting of climate change mitigation projects (see Watt et al. 1995). These stakeholders would also rely on the assistance of technical consultants to conduct the monitoring and evaluation tasks; additional participants might include university staff, nongovernmental organizations, and members of governmental agencies. If the evaluation of the project is to be more than calculation of GHG estimates — e.g., a process evaluation designed to improve project implementation — then "outside" consultants who are not involved in the project implementation should conduct the work due to their objective (independent) perspective. This recommendation is based on the assumption that distinctly different evaluation and implementation teams will enhance the credibility and integrity of evaluation. Because the separation of project evaluation and implementation functions is controversial, however, the "pros" and "cons" of such a separation need to be presented in the guidelines.

Currently, no rules exist for what kinds of organizations will verify monitoring and evaluation results. Some possibilities include government agencies, private sector firms that specialize in verification, an intergovernmental body such as the FCCC subsidiary bodies, or groups of advisors recognized by the FCCC. The guidelines could also recommend that independent verification *teams* be established (see Watt et al. 1995). The verification teams could either be composed of members from host and investor countries for joint implementation projects, or from an international agency, such as the United Nations (UN), for other projects. Individual verifiers or verification teams would be responsible for conducting the verification activities described in Section 3.8

Some resolution of disputes over verification results will also be needed:

> "Because verification has the potential to be contentious, it should be possible for third parties, as well as the host and investor country parties, to challenge the verification results, in order to encourage watch-dogging between countries. Recourse in the event of disagreement about the results of a verification could include resolution by the initial verification team, introduction of a second verification team, development of new calculation methodologies, or recourse to a tribunal, depending on the project and the nature of the disagreement." (Watt et al. 1995)

The tribunal might consist of people from the UN, or from a country. If the latter, someone may still be needed at the international level to monitor the activities of individual countries. The tribunal might also be responsible for developing a common set of standardized MERV guidelines. This is important not only for reporting GHG reductions internationally, but also for investment purposes: investors would probably welcome a standardized set rather than a diverse set of guidelines across different host countries.

In addition to formal designations to ensure cooperation for conducting the MERV activities, there will be a need for informal cooperation among all the parties involved. The guidelines should encourage this type of cooperation, for example, through workshops and conferences at the regional, national, and international levels.

3.10.2. Qualifications of MERV personnel and organizations

Experienced personnel in project impact evaluation and calculating emissions are needed. Based on the experience of DOE's Voluntary Reporting Program, one of the major problems encountered was the limited expertise in emissions estimation. We expect these same problems to occur in the monitoring and evaluation of emissions and emission reductions. Furthermore, because of the diverse individuals and organizations involved in the MERV of energy savings and carbon sequestration with varying levels of technical expertise, the guidelines may need to recommend qualification criteria for allowing these people to report, monitor, evaluate and verify GHG reductions, so that the findings are perceived as objective and credible. Certification workshops may be needed to ensure that the activities are being conducted in a responsible and credible manner. Training and certification should be sector specific: e.g., a certified evaluator in forestry (see Watt et al. 1995). The entity(ies) responsible for certification should be identified in the guidelines.

Certification is a concept that is employed in widely differing contexts and may include products as well as people. For example, the Forest Stewardship Council (FSC) is an independent, international organization that operates a voluntary accreditation program for organizations and companies that provide certification in the forestry sector (see their home page on the World Wide Web: http:/www.forestry.se/fsc/english/fsc.htm). The FSC does not undertake certification itself. Instead, the FSC has developed a set of principles and criteria that can be applied throughout the world, and a certification system that can be adapted to comply with local conditions. Hence, one of the FSC's most important tasks is to support efforts to develop nationally appropriate FSC certification standards. Certification in accordance with FSC guidelines is a guarantee that the company/landowner manages their forests in an environmentally appropriate, socially beneficial, and economically viable manner in agreement with existing laws and regulations and the FSC's principles and criteria. As a result, a wide range of technical personnel have been involved in the design and implementation of monitoring and verification systems (MacDicken 1997). In the context of this report, a similar organization should be established to provide principles and criteria for the monitoring, evaluation, reporting and verification of climate change mitigation projects. Some of this has already been done by the

Conference of Parties implementing the FCCC (e.g., the development of the Uniform Reporting Format); however, criteria and guidelines for an active training program for certification are lacking.

3.10.3. Staffing, training, instrumentation, and lab facilities

MERV will entail significant resources (see below), including the potential hiring and training of new staff (or contractors), equipment, and laboratory facilities. The users of the guidelines should be aware of the need for these resources prior to developing their MERV plans.

3.11. Cost of MERV

Conducting MERV activities is not inexpensive. For example, based on the experience of U.S. utilities and energy service companies, monitoring and evaluation activities can easily account for 5-10% of a project's budget (see Meier and Solomon 1995; Raab and Violette 1994). Similarly, carbon monitoring efforts require specialized equipment, methods and trained personnel that can be expensive for individual organizations to procure and maintain, and can result in similar percentage expenditures (MacDicken 1996; Ravindranath and Bhat 1997). The cost will vary by size of area, scope of project, variation within and between land use types, type of monitoring, and amount of training required.

Early in the process of developing guidelines, the cost of implementing the guidelines will need to be examined, and the costs will need to be disaggregated by institution as well as by activity (MERV). For example, some potential JI projects do not fix enough carbon to economically administer or monitor:

> ". . . it may be necessary to make preliminary estimates of monitoring costs at the proposal development stage. When designing a monitoring system, the cost of measuring each component should be estimated and compared to the value of carbon." (MacDicken 1996)

On the other hand, the MERV costs need to be considered in the broader context of the growing threat of global climate change from increasing emissions of greenhouse gases. For example, there is an educational value in MERV guidelines:

> "Climate change may become a matter of increasing public concern in the future, and organizations may consequently wish to determine the extent of their greenhouse gas liabilities. To do this, they would need to go through a process essentially identical to preparing a report under the Voluntary Reporting Program. By educating reporters on the sources of greenhouse gas emissions within their organizations, the Voluntary Reporting Program helps to create the expertise needed to identify possible new low-cost methods for reducing emissions." (DOE 1996a)

Several of the issues described in this chapter can be addressed by more than one option, each having different transaction costs. As discussed in Section 3.1, because of concerns about high transaction costs in responding to MERV guidelines, the guidelines cannot be too burdensome: the higher the transaction costs, the less likely organizations and countries will try to develop and implement climate change mitigation projects. In sum, actual (as well as perceived) transaction costs discourage some transactions from occurring. Tradeoffs are inevitable, and a balance needs to be made between project implementation and the level of detail (and costs) of MERV reporting guidelines. We return to this issue in the concluding chapter when we discuss "policy rules" for helping reduce transaction costs.

3.12. Summary

Based on our review of the literature and existing guidelines and protocols, we compiled a list of generic issues that need to be addressed in the development of MERV guidelines. In Table 6, we summarize the critical questions for each of these issues and, where possible, provide possible options for addressing these questions. For most of these issues, there is not one simple answer. Several alternatives may be possible for addressing some of the issues, while guidance from policymakers (rather than guidelines) will be needed for addressing other issues (see Chapter 6).

In the next two chapters (Chapter 4 and 5), we discuss methodological issues in detail (e.g., use of engineering models and explanations of how carbon content in wood and other material is measured) in the energy and forestry sectors, respectively. Readers can skip these chapters and proceed to Chapter 6 where we summarize our review of existing protocols and guidelines as they relate to the issues described in the previous chapters and present our key conclusions.

Table 6. Generic MERV Issues and Potential Response Options

Generic issue	Potential Response Options
Credible baseline Monitoring domain Leakage	Identify most likely areas of leakage and possible mitigation measures.
Net GHG and other impacts Free riders, project spillover, and market transformation	Use net-to-gross ratios (EPA's CVP) and comparison groups. Assess market effects and market barriers.
Precision of measurement Confidence levels Sampling	Use a 75% confidence level (EPA's CVP), or provide options for addressing precision (Winrock). Estimate variance, confidence intervals, or standard error (SGS Forestry). Use 20-30% standard error (SGS Forestry), or lower range of standard error (Moura Costa). Develop measurement standards (MacDicken).
MERV frequency	Reporting depends on schedule of payments for carbon credits. For monitoring, focus on key parameters for forestry projects (Ravindranath and Bhat). Examine variables and monitoring methods. Consider seasonality.
Persistence of impacts Institutional capabilities Risks and uncertainties	Use monitoring, default, and inspection options (EPA's CVP). Annual monitoring for forestry projects. Monitoring every 3 years for energy projects. Rank projects by likelihood of persistence of GHG emissions reductions. Monitor project after termination.
Multiple reporting	Ask project developers to report on multiple reporters (DOE).
Verification of GHG reductions Responsible parties Frequency	Use third-party verifiers. Use verification system (SGS Forestry). Certify verifiers. Use multi-tiered crediting: credits vary by type of verification (Watt et al.).
Risks and uncertainties Reliability of estimates Credibility of institutions Controllable risks	Provide a contingency plan (WBCSD). Discuss key uncertainties. Use confidence intervals. Develop MERV protocols and guidelines. Use default estimates where appropriate. Monitor factors affecting risk.
Institutional capabilities Local institutions Administrative burden Political impacts Roles and responsibilities Qualifications & training	Request information on institutional capacities and relationships among project stakeholders (World Bank; SGS Forestry). Use different parties for implementation, evaluation, and verification. Use independent verification teams (Watt et al.). Develop qualification criteria. Provide training and certification workshops.
Cost of MERV	Disaggregate costs by institution and MERV activity. Balance tradeoffs between cost and other MERV issues. Set cap at 10% of total project budget.

CHAPTER 4. MERV ISSUES AND METHODOLOGIES FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY PROJECTS

In this chapter, we briefly review the different types of energy efficiency and renewable energy projects that will be subject to MERV guidelines and discuss one of the key MERV issues (monitoring domain) that the guidelines need to address. The rest of this chapter describes the issues connected with the use of alternative methodologies that can be used for data collection, monitoring, and evaluation.

4.1. Project Types

MERV issues for two types of projects are examined in this chapter: energy efficiency and renewable energy projects. Both types of projects may affect the generation of energy from fossil fuel sources, thus reducing GHG emissions. MERV issues for GHG emissions reductions are similar for both types of projects.

The types of energy-efficiency projects considered in this section are:

- end-use energy efficiency
- improvements in generation (e.g., capacity factor improvements, fuel switching, increases in lower emitting capacity, efficiency improvements)
- improvements in transmission and distribution (i.e., reducing losses in the delivery of electricity or district heat from the power plant to the end user)
- cogeneration and waste heat recovery
- transportation (e.g., efficient vehicles and demand reduction)

We provide a more detailed listing of end-use energy-efficiency projects in Table 7; this table is not an exhaustive list, but is for illustrative purposes only. In many cases, the proposed projects could be targeted to one or more of the building sectors (residential or commercial) as well as the industrial sector. In all cases, energy-efficiency projects reduce the amount of energy needed to provide given levels of services. If this energy is derived from carbon-based fuel combustion, GHG emissions are reduced. In this chapter, we do not cover alternative fuel vehicles, cogeneration, and methane emissions reduction projects, although methodologies similar to the ones presented in this chapter could be used for these kinds of technologies.

Table 7. Examples of End-Use Efficiency Measures

Space Conditioning Thermal storage Duct sealing and balancing Improved efficiency Improved building design	**Refrigeration** Defrost control Multi-stage compressors Insulation/Weatherization High efficiency refrigeration cases
Water Heating Insulation blankets Heat pump water heaters Variable speed compressors Flow restricters High efficiency water heaters	**Lighting** High efficiency ballasts and reflector systems Lighting controls and occupancy sensors Daylight dimmers/switches Compact fluorescents Efficient fluorescent lamps High intensity discharge lamps
Building Envelope Insulating glass Low emissivity glass Insulation **Controls** Energy management systems	**Process Improvements** Drying/curing efficiency Economizers in recovery in steam systems Waste heat recovery Boiler and furnace maintenance Air compressor efficiency Repairing leaks and insulating tanks and pipes
	Operations and Maintenance
Motors Variable speed drives Improved motor rewinding High efficiency motors	**Ventilation** Improved efficiency Variable air volume Multi-speed or variable-speed motor

Renewable energy projects include solar thermal electricity generation and solar space conditioning, photovoltaics, wind, and hydroelectric. Renewable energy projects supply the amount of energy needed to provide a given level of service and are, therefore, similar to energy supply projects as well as energy-efficiency projects that reduce demand. If the renewable energy project displaces energy from carbon-based fuel combustion, GHG emissions are reduced. Biomass projects, which will require the MERV of energy displacement and carbon sequestration impacts, are discussed in the next chapter on forestry.

4.2. MERV Issues

Some of the key MERV issues affecting the energy sector are monitoring domain issues (see Sections 1.2.1 and 3.3.1). Energy efficiency and renewable energy projects can be implemented at the point of production, transformation, transmission, or end use. Thus, one of the monitoring domain issues to address is whether one will measure the GHG reductions and other impacts of energy-efficiency or renewable energy projects at the site of consumption, or further up the line toward the source of generation. What should the optimal system boundary be for the monitoring domain? Is there an easy rule of thumb to use for defining the optimal system boundary? Or must one monitor a country's entire national energy system for all energy-efficiency projects? We believe monitoring domain issues need to be identified during the project design stage, in order to avoid some monitoring domain issues (e.g., leakage) during the monitoring and evaluation stages. When leakage does occur, it may be mitigated or carbon estimates can be adjusted, such as a flat-rate adjustment to project-based abatement figures (Heister 1996).

When measuring the carbon reduction or sequestration impacts of energy-efficiency projects, it is possible that the actual reductions in carbon emissions are less than estimated because of changes in the behavior of project participants. For example, some occupants of buildings might raise their thermostat settings for winter heating due to lowered incremental energy costs resulting from improved insulation (commonly referred to as "snapback" or "takeback"). There is some debate in the literature regarding whether snapback is a significant factor for many efficiency measures.[1] There is also controversy on how any measured snapback effect should be included in a net benefit calculation. Some argue that it should be a debit to savings, while others argue that it represents enhanced service or increased amenity value and should at least net out any possible debit caused by increased usage. We believe it is important to raise the issue of snapback in this paper as it affects the calculation of GHG emissions, however, because of the uncertainties surrounding the topic, we believe it is premature at this time to include the issue in a MERV protocol.

Interventions targeting production or transmission efficiency require different monitoring and evaluation techniques than for distributed end-use interventions. For example, because production and transformation efficiency projects generally occur at one or a handful of facilities, sampling strategies

[1] A comprehensive review of 42 different snapback studies concluded that snapback can occur, but it is a localized phenomenon limited to specific end uses (Nadel 1993). For example, for residential space heating, 15 studies indicated that little if any takeback was likely, and for residential water heating there was no evidence of takeback. For residential lighting, increased operating hours increased energy use of compact fluorescent lamps by approximately 10% relative to what use would have been if operating hours remained unchanged (Nadel 1993). Clearly, one needs to examine the marginal use and demand for energy and non-energy services as part the calculation of snapback.

for monitoring and evaluation are not required to determine GHG emissions impacts. Measurements must be taken at more than one site in order to monitor a single transmission efficiency project. Because end-use efficiency projects typically target a large number of energy consumers, statistical evaluation methods are required.

The MERV of energy-efficiency projects is expected to be similar to that for renewable energy projects, although the former may be somewhat more difficult because energy-efficiency projects are typically smaller and more diffuse than larger, more centralized power supply options. Also, the output of renewable energy projects may be easier to measure (e.g., using a meter) compared to energy savings from energy-efficiency projects.

The evaluation of electric end-use efficiency and renewable energy projects requires an analysis of how the generation mix would have changed had the project not been implemented. Depending on the project, either baseload or peak load impacts (or both) will occur as a result of the project. If baseload or peak load energy is generated from fossil fuels, the reduction of energy consumption by end-users may reduce the generation required, and hence reduces the associated GHG emissions.

4.3. Data Collection and Analysis Methods

This section introduces some of the basic data collection and analysis methods used to produce energy-saving estimates (see DOE 1994b; Raab and Violette 1994). The methods vary in cost, accuracy, simplicity and technical expertise required. For example, the methods used for verification will be less technical than for evaluation, but they will require an understanding of the monitoring and evaluation processes, their results, and their applicability to the verification process. For energy-efficiency measures, verifying baseline and post-project conditions may involve inspections, spot measurement tests, or assessments (e.g., documentation of the assumptions and intent of the project design; functional performance testing and documentation evaluating the local acceptability of the energy efficiency measure(s); and adjusting the project to meet actual needs within the capability of the system) (Figueres et al. 1996).

Tradeoffs will need to be made for choosing the appropriate methods: e.g., level of accuracy and cost of data collection (see Section 4.3.7). These tradeoffs will also vary depending on the type of impacts that will be examined: energy impacts, GHG impacts, or non-GHG impacts. For example, it may be more difficult to collect data on GHG impacts than energy impacts, and non-GHG impacts than GHG impacts.

Data collection methods can include engineering calculations, surveys, modeling, end-use metering, on-site audits and inspections, and collection of utility bill data. Most monitoring and evaluation activities will focus on the collection of measured data; if no measured data is collected, then one will rely on engineering calculations and "stipulated" (or default) savings (as described in EPA's Conservation Verification Protocol — see Section 2.2.3). Data analysis methods can include engineering methods, basic statistical models, multivariate statistical models (including multiple regression models and conditional demand models), and integrative methods.

The methods used for data collection and the evaluation of non-electric end-use efficiency projects are similar to those used for electric end-use efficiency projects; there will, however, often be greater reliance on engineering methods and surveys because centralized billing information will generally not exist. Energy savings from other types of energy efficiency projects can also be calculated using the techniques in this chapter (e.g., utility bill monitoring can provide accurate savings estimates for solar thermal projects where the original fossil fuel was dedicated to the end-use requirement met by the solar system).[1] After reviewing these methods for evaluating energy savings, we discuss the calculation of GHG benefits resulting from these savings.

4.3.1. Engineering methods

Engineering methods are used to develop estimates of energy savings based on technical information from manufacturers on equipment in conjunction with assumed operating characteristics of the equipment. The two basic approaches to developing engineering estimates are engineering algorithms and engineering simulation methods (Violette et al. 1991).

<u>Engineering algorithms</u> are typically straightforward equations showing how energy (or peak) is expected to change due to the installation of an energy efficiency (or renewable energy) measure. They are generally quick and easy to apply. The accuracy of the engineering estimate, however, depends upon the accuracy of the inputs, and the quality of data that enters an engineering algorithm can vary dramatically.

<u>Engineering building simulations</u> are computer programs that model the performance of energy-using systems in residential and commercial buildings. These models use information on building occupancy

---

1 Accounting for the shifting of energy use and related changes in emissions associated with fuel-switching activities creates a potentially more complex reporting situation: for example, comparing the indirect emissions reductions from reduced electricity use with the new direct emissions from increased onsite fossil fuel use.

patterns, building shell and building orientation (e.g., window area, building shape and shading) and information on all of the energy-using equipment. The input data requirements for the more complex simulation models are extensive and require detailed onsite data collection as well as building blueprints.

Building simulation models are best suited for space heating/cooling analyses and for predicting interactive effects of multiple measure packages where one of the measures influences space conditioning. Measures best addressed by simulation models include heating, ventilation, and air-conditioning (HVAC) measures, building shell measures, HVAC interactions with other measures, and daylighting measures. Equipment measures such as lighting, office equipment, and appliance use are typically calibrated outside the simulation, except for their interactive impacts.

Building simulation models are tools, and their usefulness is a function of the skill of the modeler, the accuracy of the input information, and the level of detail in the simulation algorithms. A key component of building energy simulation methods is the appropriate calibration of these models to actual consumption data. The calibration could involve monthly energy consumption data from bills (at a minimum), kW demand meters, run-time meters, and short-term end-use metering (e.g., two to six weeks of metering). One advantage of simulation models is that they take into account such factors as weather data and interactions between the HVAC system and other end uses. A primary disadvantage is that they are very time consuming and usually require specialized technical expertise, making them costly in the long run.

Engineering estimates are often developed as part of an ongoing project tracking database. Because of changes during project implementation, the engineering assumptions used at the design stage of a project need to be changed as evaluation data are collected (e.g., number of operating hours and specific measures installed). Engineering methods for use in assessing the impacts of energy-efficiency and renewable energy projects are improving as experience points out their strengths and weaknesses. Their value for impact evaluation also is increasing as actual field data is used to adjust or recalculate savings estimates. Engineering methods are often used as a complement to other evaluation methods rather than serving as stand-alone estimates of project impacts (see below).

Although engineering approaches are improving and increasing in sophistication, they cannot by themselves produce estimates of net project impacts (see Sections 3.3.2 and 4.4). The engineering estimates generally produce estimates of gross impacts and do not capture behavioral factors such as free riders and project spillover. It is possible to incorporate free rider and spillover factors from surveys and other evaluation sources in order to calculate net impacts. Engineering analyses may be most appropriate for: (1) the initial year of project implementation where monitoring will rely on engineering estimates; (2) projects where small savings are expected; (3) large industrial customers; and (4) new construction projects.

In sum, the advantages of engineering methods are that they are relatively quick and inexpensive to use and are probably most useful when integrated with other data collection and analysis methods. The primary disadvantage is that the data used in the calculations rely on assumptions that may vary in their level of accuracy. Accordingly, engineering analyses need to be "calibrated" with onsite data (e.g., operating hours and occupancy). Thus, as project information is collected, engineering estimates can be improved.

4.3.2. Basic statistical models for evaluation

Statistical models that compare energy consumption among projects before and after the installation of energy efficiency measures have been used as an evaluation method for many years (Violette et al. 1991). The most basic statistical models simply look at monthly billing data before and after measure installation using weather normalized consumption data. If the energy savings are expected to be a reasonably large fraction of the customer's bill (e.g., 10% or more), then this change should be observable in the project's bills. Smaller changes (e.g., 4%) might also be observed in billing data, but more sophisticated billing analysis procedures are often required. A weather normalized pre-/post-change in energy use is calculated for the projects. This can be viewed as a stand-alone estimate of impacts, or it can be compared to the change in energy use among a comparison group. Statistical models are most useful where many projects are being implemented (e.g., in the residential sector).

These simple statistical comparison estimates rely on the assumption that the comparison group is, in fact, a good proxy for what project participants would have done in the absence of the project. However, there are reasons to expect systematic differences between project participants and a comparison group (see Section 3.3.2). Consequently, evaluators may start with these basic statistical approaches because they are relatively inexpensive and easy to explain; these methods generally rely only on billing data and weather data for weather normalization. Evaluators should consider augmenting these methods with survey data and other measurements to test the underlying assumptions of these simple models. Additional modeling and verification methods may be needed before the results of these basic comparisons can be accepted as accurately representing the in-field impacts of an energy efficiency or renewable energy project (see Section 4.3.3).

The advantages of basic statistical models are that comparing the billing data is inexpensive, and the results are easy to understand and communicate. The disadvantages include limited applicability (because of the need for stable building operations or lack of prior billing records (e.g., new construction)), participant samples of significant size are required for validity, and peak impacts cannot be evaluated.

4.3.3. Multivariate statistical models for evaluation

In project evaluation, more detailed statistical models may need to be developed to better isolate the impacts of an energy-efficiency or renewable energy project from other factors that also influence energy use. Typically, these more detailed approaches use multivariate regression analysis as a basic tool (Violette et al. 1991). Regression methods are simply another way of comparing kWh or kW usage across sets of projects and comparison groups, holding other factors constant. Regression methods can help correct for problems in data collection and sampling. If the sampling procedure over- or under-represents specific types of projects (e.g., large-scale energy intensive projects) among either project participants or the comparison group, the regression equations can capture these differences through explanatory variables. Two commonly applied regression methods are conditional demand analysis and statistically adjusted engineering models (Violette et al. 1991).

4.3.4. End-use metering

Energy savings can be measured for specific equipment for specific end uses through end-use metering (Violette et al. 1991). This type of metering is required before and after a retrofit to characterize the performance of the equipment under a variety of load conditions. The advantage of end-use metering is that it provides a greater degree of accuracy than engineering estimates or short-term monitoring for measuring energy use (see below). In addition, the meter can calculate the energy change on an individual piece of equipment in isolation from the other end-use loads (as opposed to billing analysis which captures the effect at the building or meter level). The disadvantages of end-use metering are: (1) it requires specialized equipment and expertise, typically more costly than the other methods, and therefore most samples need to be small; (2) the small samples may lead to biases in sample selection and problems in representativeness; (3) end-use metering of post-participation energy consumption alone does not, in and of itself, improve estimates of project impacts; and (4) end-use metering experiments to measure both pre-and post-installation consumption are difficult to construct, especially in identifying project participants before their becoming participants to allow the pre-measure end-use metering. Accordingly, end-use metering is more often seen as a data collection method (rather than a data analysis method) that can provide useful information for integrative methods (see Section 4.3.6).

4.3.5. Short-term monitoring

Short-term monitoring refers to data collection conducted to measure specific physical or energy consumption characteristics either instantaneously or over a short time period. This type of monitoring is conducted to support evaluation activities such as engineering studies, building simulation and statistical analyses (Violette et al. 1991). Examples of the type of monitoring that can take place are spot watt measurements of efficiency measures, run-time measurements of lights or motors, temperature measurements, or demand monitoring. Short-term monitoring is gaining increasing attention as evaluators realize that for certain energy-efficiency measures with relatively stable and predictable operating characteristics (i.e., commercial lighting, some motor applications, wind turbines), short-term measurements will produce gains in accuracy nearly equivalent to that of longer-term metering at a fraction of the cost.

Short-term monitoring is a useful tool for estimating energy savings when the efficiency of the equipment is enhanced, but the operating hours remain fixed. Spot metering of the connected load before and after the activity quantifies this change in efficiency with a high degree of accuracy. For activities where the hours of operation are variable, the actual operating (run-time) hours of the activity should be measured before and after the installation using a run-time meter. Thus, the advantage of the spot meter is that it is simple and easy to apply. This method is more accurate than using engineering calculations, since the parameters are measured instead of being assumed. The primary disadvantage is its limited applicability (i.e., where operating hours are the same before and after treatment). Similar to end-use metering, short-term monitoring is more often seen as a data collection method (rather than a data analysis method) that can provide useful information for integrative methods (see Section 4.3.6).

4.3.6. Integrative methods

Integrative methods combine one or more of the above methods to create an even stronger analytical tool. These approaches are rapidly becoming the state of the practice in the evaluation field (Raab and Violette 1994). The most common integrative approach is to combine engineering and statistical models where the outputs of engineering models are used as inputs to statistical models. These methods are often called Statistically Adjusted Engineering (SAE) methods or Engineering Calibration Approaches (ECA). Although they can provide more accurate results, integrative methods typically increase the complexity and expense. To reduce these costs while maintaining a high level of accuracy, a related set of procedures has been developed to leverage high cost data with less expensive data.

These leveraging approaches typically utilize a statistical estimation approach termed ratio estimation that allows data sets on different sample sizes to be leveraged to produce estimates of impacts (see Violette and Hanser 1991).

4.4. Net Energy Impacts and Comparison Groups

As noted in Sections 3.3.2, comparison groups are needed for evaluating the net impacts of energy efficiency and renewable energy projects. This approach can capture time trends in consumption that are unrelated to project participation. For example, if the comparison groups' utility bills show an average reduction in energy use of 5% between the pre- and post-periods, and the participants' bills show a reduction of 15%, then it may be reasonable to assume that the estimated project impacts will be 15% minus the 5% general trend for an estimated 10% reduction in use being attributed to the project. Similarly, if the project has affected 80% of the comparison group, then all or a portion of the energy savings from the comparison group may be added to the direct impacts to the project (as part of the market transformation aspects of the project). None of the existing guidelines and protocols, however, specifically recommend including the additional savings due to the impacts of the project outside of the project area. This is a monitoring domain issue that the guidelines or policy rules need to address (see Sections 1.2.1 and 3.3.1).

4.5. Calculating GHG Impacts

Net emission reductions can be calculated in three ways: (1) if GHG emissions are monitored, then the difference in measured emissions between the reference and project case is calculated; (2) if emissions reductions are based on fuel-use or electricity-use data, then default emissions factors can be used, based on utility or nonutility estimates (e.g., see Appendix B in DOE 1994b); or (3) emissions factors can be based on generation data specific to the situation of the project (e.g., linking a particular project on an hourly or daily basis to the marginal unit it is affecting). In the last two methods, emissions factors translate consumption of energy into GHG emission levels (e.g., tons of a particular GHG per kWh saved). In contrast to the default emission factors (method #2), the advantage of using the calculated factors (method #3) is that they can be specifically tailored to match the energy efficiency characteristics of the activities being implemented by time of day or season of the year. For example, if an energy-efficiency project affects energy demand at night, then baseload plants and emissions will probably be affected. If a solar photovoltaic project, however, generates electricity during the middle of the day, then peak capacity plants and emissions may be affected. Since different fuels are typically used for baseload and peak capacity plants, then emission impacts will also differ.

The calculations become more complex if one decides to use the emission rate of the marginal generating plant (multiplied by the energy saved) for each hour of the year, rather than the average emission rate for the entire system (i.e., total emissions divided by total sales) (Swisher 1997). For the more detailed analysis, one must analyze the utility's existing expansion plan to determine the generating resources that would be replaced by saved electricity or displaced by renewables, and the emissions from these electricity-supply resources. Moreover, one would have to determine if the planned energy-efficiency measures or renewables would reduce peak demand sufficiently and with enough reliability to defer or obviate planned capacity expansion. If so, the deferred or replaced source would be the marginal expansion resource to be used as a baseline. This type of analysis may result in more accurate estimates of GHG reductions, but this method will be more costly and require expertise in utility system modeling.

4.6. Summary

Several methods are available for collecting data on energy-efficiency and renewable energy projects: e.g., engineering calculations, surveys, modeling, end-use metering, on-site audits and inspections, and collection of utility bill data. Similarly, several methods are available for evaluating these kinds of projects: e.g., engineering methods, basic statistical models, multivariate statistical models (including multiple regression models and conditional demand models), and integrative methods.

There is no one approach that is "best" in all circumstances (either for all project types, evaluation issues, or all stages of a particular project). The costs of alternative approaches will vary and the selection of evaluation methods should take into account project characteristics. The appropriate approach depends on the type of information sought, the value of information, the cost of the approach, and the stage and circumstances of project implementation. The applications of these methods are not mutually exclusive; each approach has different advantages and disadvantages (Table 8). Using more than one method can be informative. Employing multiple approaches, perhaps even conducting different analyses in parallel, and integrating the results, will lead to a robust evaluation. Such an approach builds upon the strengths and overcomes the weaknesses of individual approaches. Also, each approach may be best used at different stages of the project life cycle and for different measures or projects. An evaluation plan should specify the use of various analytical methods throughout the life of the project and take into account the financial constraints, staffing needs, and availability of data sources.

Within the application of impact evaluation methods, several trends are being observed in the field of project evaluation which may affect the type of MERV guidelines that may be developed: (1) a resurgence in the use of engineering methods for energy-efficiency project evaluation, as engineering models have improved and have integrated the results of field studies; (2) declining costs of infield metering and monitoring technologies; (3) better measurement and data collection protocols; and (4) an increased emphasis on collecting data during project implementation to better support project evaluation (Raab and Violette 1994).

Table 8. Advantages and Disadvantages of Data Collection and Analysis Methods

Methods	Advantages	Disadvantages
Engineering Methods	Relatively quick and inexpensive. Most useful as a complement to other methods. Methods are improving.	Need to be calibrated with onsite data. Not good for net impact evaluation.
Basic Statistical Models	Relatively inexpensive and easy to explain.	Assumptions need to be confirmed with survey data and other measured data. Limited applicability. Cannot evaluate peak impacts. Large sample sizes needed.
Multivariate Statistical Methods	Can better isolate project impacts than basic statistical models.	Same disadvantages as for basic statistical models. Relatively more complex, expensive, and harder to explain than basic statistical models.
End-use Metering	Most accurate method for measuring energy use. Most useful for data collection, not analysis.	Can be very costly. Small samples only. Requires specialized equipment and expertise. Possible sample biases. Difficult to generalize to other projects. Does not, by itself, calculate energy savings. Difficult to obtain pre-installation consumption.
Short-term Monitoring	Useful for measures with relatively stable and predictable operating characteristics. Relatively accurate method. Most useful for data collection, not analysis.	Limited applicability. Does not, by itself, calculate energy savings.
Integrative Methods	Relatively accurate.	Relatively more complex, expensive, and harder to explain than some of the other models.

CHAPTER 5. MERV ISSUES AND METHODOLOGIES FOR FORESTRY PROJECTS

In this chapter, we briefly review the different types of forestry projects that will be subject to MERV guidelines and discuss some of the unique features of forestry projects that distinguish them from energy-efficiency and renewable energy projects. After examining two MERV issues in particular (i.e., monitoring domain and socioeconomic impacts), we describe the following methodological issues: (1) measurement perspectives; (2) methodologies for data collection, monitoring, and evaluation; (3) inventory analysis of carbon pools; and (4) net carbon impacts.

5.1. Introduction

Unlike energy efficiency and renewable energy projects, forestry projects may not only reduce emissions but may also remove carbon from the atmosphere and store it (carbon sequestration). Carbon sequestration plays an important role in reducing accumulated carbon dioxide in the atmosphere. Green plants remove (sequester) carbon from the atmosphere by way of photosynthesis, using the carbon to make biomass in the form of roots, stems, and foliage. The sequestration process ends when the carbon is released back to the atmosphere principally as carbon dioxide, through either combustion or decay processes. Carbon can also be removed from the forest as trees are harvested. Some of the carbon, however, might not return directly to the atmosphere. If the trees are used to make wood products, a portion of the carbon sequestered over the growth period will remain in solid form up to several decades. If the harvested trees are used to produce energy, carbon will be released through combustion. This could offset carbon that would have been released through the burning of fossil fuels.

5.2. Types of Projects

The forestry sector affects a broad range of potential GHG sources, emissions reductions activities, and carbon sequestration activities. There are basically three categories of forest management practices that can be employed to curb the rate of increase in carbon dioxide in the atmosphere (Brown et al. 1996). These categories are: (1) management for conservation, (2) management for storage, and (3) management for substitution.

The goal of conservation management is primarily to conserve existing carbon pools in forests as much as possible through options such as controlling deforestation, protecting forests in reserves (forest preservation), modified forest management (e.g., reduced impact logging, hardwood control, precommercial thin, commercial thin, firewood harvests, fertilization, and prescribed fire), and controlling other anthropogenic disturbances such as fire and pest outbreaks.

The goal of storage management is to expand the storage of carbon in forest ecosystems by increasing the area or carbon density of natural and plantation forests and increasing storage in durable wood products. Thus, this would include afforestation (i.e., the planting of trees in areas absent of trees in recent times), reforestation (i.e., the planting of trees where trees had recently been before, but currently are absent), urban forestry (i.e., the planting of trees in urban or suburban settings), and agroforestry (i.e., planting and managing trees in conjunction with agricultural crops).

Finally, substitution management aims at increasing the transfer of forest biomass carbon into products (e.g., construction materials and biofuels) that can replace fossil-fuel-based energy and products, cement-based products, and other building materials. This type of management would include short-rotation woody biomass energy plantations.

Forestry projects can also be classified by carbon stocks (Table 9) (Swisher 1996). This type of typology is useful because forestry projects have different carbon flows: some store carbon in standing natural forest, some accumulate carbon in new biomass grown in the project, some accumulate carbon in harvested products that enter long-term storage, and biomass energy farms and plantations store additional net carbon in unburned fossil fuel by preventing carbon emissions from fossil fuel use. The relative size of the carbon pools, and potential changes in the carbon pools from climate change mitigation projects, will determine the type of monitoring and evaluation that will be needed for a specific project. If the carbon pools are small, or if the potential changes to the carbon pool from a project are minor, then less resources will need to be developed for MERV activities.

Table 9. Forestry Projects and Parameters for Calculation of Net Carbon Storage
("+" means the carbon stock applies to the project classification; "0" means it does not)

	Carbon Stock				
Project Type	**Standing Biomass**	**New Biomass**	**Harvested Biomass**	**Soil Carbon**	**Saved Fossil Energy**
Conservation management					
Forest reserves /reduced deforestation	+	0	0	+	0
Natural forest management	+	0	+	+	0
Storage management					
Timber plantations /wood products	0	+	+	+	0
Forest/ecosystem restoration	0	+	0	+	0
Agroforestry/social forestry	+	+	+	+	0
Fuelwood farms (noncommercial)	+	+	0	+	0
Dryland restoration (annual crop)	0	0	+	+	0
Substitution management					
Biomass commercial energy farms	0	0	0	+	+
Biomass energy plantations	0	+	0	+	+

Source: Swisher (1996)

5.2.1. Biomass energy plantations

The conventional view of forest management assumes that initial forest establishment is followed by a relatively extensive period of growth (and carbon accumulation). In contrast, biomass energy plantations occupy an intermediate position between forestry and annual agriculture. With woody biomass crops, harvesting occurs approximately every 5-12 years, and regeneration is accomplished by methods that rely on regrowth of new stands from the root stock of the harvested stand (DOE 1994b).

Biomass energy plantations also occupy an intermediate position between forestry and energy supply projects. Analysis of these projects will depend upon information regarding how energy would have been supplied in the absence of the project. One needs to account for emissions related to the biomass fuels and the displaced fossil fuels in the energy supply sector, and the capture of carbon in the forestry sector. The carbon capture resulting from woody biomass plantations can be analyzed in conventional forestry sector terms. At the same time, the release of carbon from the combustion of biomass fuel and the displacement of emissions from fossil fuels relates more closely to activities in the energy supply sector. The MERV of the two components of biomass projects is important because the use of biomass on a renewable basis as a substitute for fossil fuels typically yields greater GHG abatement benefits than sequestration alone (World Bank 1994a).

5.2.2. Unique features of forestry projects

Some unique features make the MERV of forestry projects challenging. First, the long gestation periods of forestry projects entail a long-term monitoring process: it takes many years for a forest to grow, and many years to track the "lifetime" of wood products (see Section 5.6.6). The long gestation periods lead to uncertainty over the sustainability of the project, and affect the timing and number of observations that may be needed for measuring the persistence of GHG emission reductions and carbon sequestration (see Section 3.6).

Second, the varied extraction of wood during the life of a project necessitates multiple monitoring approaches: some forestry projects involve the harvest of timber or pulpwood for use in wood products (see Section 5.6.6). Of the carbon that reaches wood products, some remains only for a short time (1-5 years), but a significant amount remains stored in the wood products for long periods (on the order of decades) before returning to the atmosphere (DOE 1994b). The unknown fate of some of these products adds to the uncertainty level of impact measurement. The most conservative approach is to treat carbon destined for wood products as if it is released immediately after the harvest (DOE 1994b).

Third, forestry activities can have a wide range of effects: e.g., reforestation may increase fertilizer use, which can increase nitrous oxide emissions, and fossil fuel use in harvesting and transporting timber. Finally, forestry activities may have indirect impacts on GHG emissions (e.g., urban tree planting can decrease the extent and severity of urban heat islands, potentially reducing the consumption of electricity to cool buildings, thereby reducing GHG emissions).

5.3. MERV Issues

Six key MERV issues affecting the forestry sector need to be addressed by any guidelines: (1) the duration of measurement (e.g., measure carbon flows for one week, one month, six months, one year, five years, or the lifetime of a wood product (e.g., furniture)); (2) the frequency of measurement (e.g., annually, biannually, or biennially (see Section 3.5); (3) monitoring of carbon after the carbon is harvested, particularly if wood is harvested for fuel; (4) the monitoring domain, to account for project leakage, if deemed significant; (5) the calculation of net impacts using comparison plots (see below); and (6) both direct and indirect impacts, not just carbon sequestration.

5.3.1. Monitoring domain

Extensive studies of global, regional, and national level carbon inventories have been undertaken in the last decade, but, relatively little work has been done to monitor impacts of carbon storage projects (Figueres 1996). The lack of work in this area may be due to the difficulties in addressing monitoring domain issues (see Sections 1.2.1 and 3.3.1). Questions of leakage and off-site baseline changes may determine the success or failure of forest preservation projects, but they are extremely difficult to quantify.

There are three key monitoring domain issues that need to be addressed in forestry projects. First, should the impacts of forestry projects be examined only at the area of implementation (e.g., an area where a reforestation project occurs) or at the point of use (e.g., where the wood from that forest is used for furniture)?

Second, should the impacts of forestry projects be examined only at the project area, or should it cover a wider region (the "leakage problem")? For example, the preservation of a mature forest in one country could lead to increased harvest of timber elsewhere in the country or in another country to meet market demand. Similarly, counterproductive effects of afforestation could arise if the conversion of the agricultural land had market effects that encouraged other parties to (1) convert their forest to agricultural land, (2) avoid tree planting they might otherwise have done, or (3) harvest their existing forest stands earlier than they might otherwise have done. While some believe that market leakage is not expected to rise to a significant level compared to the effect of capturing carbon (Swisher 1996), we believe that leakage should still be addressed in the guidelines.

And third, should the impacts of forestry projects continue to be assessed when forested areas are later transformed into agriculture, grassland and range?

For forestry projects, the Land Use and Carbon Sequestration (LUCS) model, available from the World Resources Institute, is one tool that may be able to address off-site leakage (Faeth et al. 1994; MacDicken 1996). The LUCS model is a project-based computer model that tracks the changes in carbon density associated with land use changes (e.g., conversion of forested areas to agriculture) and provides estimates of the costs and benefits of such changes. Direct measurements and default assumptions are used to calculate the changes and impacts. One of the more important outputs of the model is the cost per ton of carbon sequestered. The model identifies leakages, and future work is being undertaken to modify the model so that leakages can be evaluated comprehensively and quantitatively (personal communication from Willy Makundi, Lawrence Berkeley National Laboratory, July 24, 1997).

Defining the appropriate boundaries for monitoring domains must take into account important GHG pools, fluxes and leakage, both over space and time. Different techniques (see Section 5.5) are available for assessing multiple monitoring domains in forestry projects (Andrasko 1997). At the national scale, remote sensing can be used to detect land-use and land-cover changes. At the regional scale, remote sensing can be used with ground-truthing and forest inventory techniques. And at the project level, remote sensing, ground-truthing, creation of permanent plots, forest inventory data or surveys, or allometrics from other inventories applied to a new site can be used. Currently, there are weak linkages in assessing multiple monitoring domains(Andrasko 1997). One potential solution to strengthening these linkages is the use of "nested monitoring systems" where an individual project's monitoring domain is defined to capture the most significant GHG fluxes and where provisions are made for monitoring GHG flows outside of the project area by regional systems or national GHG inventory monitoring systems (Andrasko 1997).

Another potentially useful tool for addressing monitoring domain issues in forestry projects is the development of a "leakage index" that helps determine when leakage is likely to be an issue (Brown et al. 1997). The leakage index covers the following information: (1) the main drivers of land use change and deforestation resulting from demand for agricultural land, fuelwood and timber; (2) the market boundaries of the demand (local or export use); (3) types of projects and their components; (4) conditions under which project components become vulnerable to leakage (e.g., decreased agricultural or timber output); (5) an assessment of the project's potential for leakage (e.g., moderate or high, and short or long term); and (6) possible mitigation strategies for avoiding leakage. Using this index, one can redesign projects or, if too costly or not feasible, carbon sequestration benefits will need to be recalculated to reflect the project's soundness (similar to what is proposed in the energy sector — see Section 4.2). In sum, the leakage index should be helpful for systematically addressing the potential for leakage.

5.3.2. Socioeconomic impacts

The socioeconomic benefits of forestry projects have made these kinds of projects beneficial in the minds of supporters of climate change mitigation projects; however, the evaluation of socioeconomic impacts is challenging and requires different resources and expertise than those associated with the monitoring of carbon flows in forests. The socioeconomic impacts are particularly relevant for forestry projects because they are more likely to address the root causes of deforestation (Andrasko et al. 1996). The socioeconomic benefits of forestry projects are particularly important for rural and developing countries, where forestry projects can have very positive impacts for the local population (e.g., ecotourism or forest warden jobs). The sustainability of forestry projects will be improved if these kinds of impacts are accounted for and recognized (see Section 3.2.3).

5.4. Measurement Perspectives

There are two different perspectives in measuring carbon stock and flow in forests: the first perspective emphasizes the dynamics of carbon flow, while the second perspective is based on an equilibrium model of carbon storage. In the first perspective, periodic measurements of carbon stock and flow are needed because of the dynamics of carbon stock and flow in forests (MacDicken 1996). Thus, guidelines are needed to measure the net flows of carbon as accurately as is practical, accounting for all positive flows (emissions) of carbon from forests (e.g., from the combustion and decay of organic matter and the use of fossil fuels in machinery) and negative flows (capture) of carbon through photosynthesis to forests. Furthermore, every action undertaken in the management of forests causes changes in stocks of biomass and, therefore, in flows of carbon. Forestry activities also typically trigger a sequence of effects that change through time, so that the measurement of carbon flows must account for these dynamic effects (e.g., from the time a forest is established until a forest is removed by harvest or a natural disturbance).

In the second perspective, for the purpose of carbon offset analysis, the dynamics of the carbon flows over time may not need to be monitored (Swisher 1996). Only long-term (more than 20 years) average or steady-state carbon storage densities need to be analyzed. The MERV of projects would therefore be done less frequently than under the first perspective.

Because we expect carbon credit claims to be verified over short periods of time (e.g., annually) and by high quality data (e.g., field measurements), we use the first perspective as the starting point for a discussion of data collection and analysis methodologies in the forestry sector.

5.5. Data Collection and Analysis Methods

The measurement of a project's carbon fixation necessitates specialized tools and methods drawn largely from experience with forest inventories and ecological research. Monitoring and verifying carbon accumulation in forestry projects must be cost effective and accurate to known levels of precision (see Section 3.4). Monitoring systems should be built upon standard forestry approaches to biomass measurement and analysis, and apply commonly accepted principles of forest inventory, soil science and ecological surveys. Field research methods need to be adapted for use with commercial-scale inventories, at levels of precision specified by funding agencies. Specific methods and procedures should be assembled on a project-specific basis, with the types and extent of monitoring ultimately determined by the relative costs and carbon returns of each measurement type.

An alternative to an inventory approach for estimating annual flows of carbon is the use of models of the impacts of certain forestry practices on carbon flows into and out of forest carbon sinks. These models start from an estimate of a carbon stock for a specific forest type at a specific site. Then, based on information from forest practices, the models develop estimates of annual carbon flows. The models need to be corrected/calibrated with measured data periodically. Some models are already available for simple conditions and standard treatments, such as tree planting on agricultural land. More complex models are being developed and appear to be progressing rapidly (DOE 1994b). However, field measurements are generally preferred over standard tables and computer models, because site-specific field studies provide higher quality data and thus higher credibility.

Six general monitoring approaches have been proposed to monitor carbon fixed through forestry projects (based on MacDicken 1997). The first approach uses a series of highly simplified assumptions to estimate total carbon sequestration. For example, assumptions could include: the number of trees planted in either woodlots or agroforestry systems, initial stocking rates, mean annual stemwood volume increments, a biomass multiplier factor, and harvest rates. The assumptions are then inputted into a model to estimate the amount of sequestered carbon. This approach requires little time and effort, and the gross estimates (not net estimates) are probably neither accurate nor precise (MacDicken 1997). This approach is similar to the engineering analyses used in estimating energy savings without field data (see Section 4.3.1).

The second approach relies on remote sensing and ground truthing (ground-based measurements) to monitor land area changes, map vegetation types, delineate strata for sampling, and assess leakage and base case assumptions. Many existing national and international projects and programs have made use of this technology for land cover change research at a national or international level (Skole et al. 1997). The Face Foundation in the Netherlands and Winrock International have used satellite imagery for evaluating climate change mitigation projects (Face Foundation 1997; MacDicken 1996).[1] Attempts to estimate biomass from remote sensors have generally been costly and have had mixed results (MacDicken 1997). Also, very little work of this kind has been done in tropical forests, which are more diverse and spatially variable than temperate forests. To date, no one has measured carbon using remote sensing. Skole et al. (1997) have proposed an international system for monitoring land cover change which includes studies in specific locations for field validation and accuracy assessments for the large area analyses; these sites could also be useful for evaluating project impacts, if integrated with the approach described next.

The third approach is the periodic inventory of carbon in baseline and project cases, analogous to the commercial assessment of timber volume or biomass. Commercial-scale carbon inventories can be performed at virtually any level of precision desired by inventory sponsors and provide flexibility in the selection of methods, depending on the costs and benefits of monitoring. One inventory-based system that has been extensively peer reviewed and field tested was developed by the Winrock International Institute for Agricultural Development and is briefly described in Section 2.1.6. We discuss some components of this approach later in the next section.

The fourth approach is research studies that use more intensive data collection and analysis methodologies to typically test research hypotheses. Research studies can provide useful detailed monitoring estimates for determining how much carbon is sequestered by projects, but it is usually more costly than other monitoring activities (MacDicken 1997).

The fifth approach uses surveys of project field activities to see what was actually implemented in the project. This type of monitoring would provide useful data for the evaluation of carbon mitigation and sequestration projects, especially if the surveys are combined with the third approach described above.

The sixth approach is the monitoring of wood production, use, and end product data in order to develop historical and trend data for the development of accurate baselines. Also, an account needs to be made of what happens to the wood once it is felled or trees and branches die (Section 5.6.6). If dead wood is regularly collected, it should be measured and its use recorded, and this monitoring activity would provide the needed information.

[1] The Face Foundation was set up by Sep (the Dutch Electricity Generating Board) to fund projects to sequester some of the carbon dioxide emitted into the atmosphere by the burning of fossil fuels when generating electricity in the Netherlands. Face stands for Forests Absorbing Carbon dioxide Emissions.

5.6. Inventory Analysis of Carbon Pools

In forestry projects, carbon accumulates primarily in four pools: above-ground biomass, below-ground biomass, soils and the litter layer. Monitoring systems need to assess the net difference in each pool for project and nonproject (or pre-project) areas over a period of time. By comparing these changes in the project area to changes in pools unaffected by project activities (i.e. comparison plots), the monitoring effort can assess the impact of the project on carbon storage. Detailed biomass measurement methods can be found in MacDicken (1996).

For each pool, measurements should start in both project and comparison areas before the project begins so as to confirm the similarity of the comparison area to the project area, and to provide a basis for determining changes in the amount and types of biomass on a particular site over time. Measurements should be made on an annual basis at the same time each year; monitoring frequency may need to be increased if there is a substantial amount of annual (as opposed to perennial) vegetation at the site (see Section 3.5). In addition to measurements, records should be kept on disturbances at the sites, whether man-made (e.g., thinnings) or natural (e.g., pest infestation).

One of the key monitoring and evaluation issues is determining which of the carbon pools are significant and which are likely to change. The significance of a carbon pool may be defined by its relative size and speed of change:

> "For example, in a forest preservation project, the carbon stored in trees may represent 70-80% of the total carbon stored on site, and consequently is a relatively significant pool. Leaf litter contains only 1% of the carbon contained in the trees and, therefore, does not represent a significant pool in terms of relative size. Changes in pools that are directly attributed to project activities should be the focus of the monitoring program, but changes in all pools need to be evaluated for their relative significance to the project's carbon balance." (EcoSecurities 1997)

Thus, it may be useful to rank the carbon pools according to their significance (relative size), vulnerability (rate of change), and direction of change (positive or negative). Pools that are relatively large and that are likely to change rapidly are very important to monitor. Pools that are relatively small and unlikely to change are not so important to monitor. A monitoring and evaluation program should adopt a conservative approach when deciding upon which pools to monitor and evaluate. Only pools that are monitored and evaluated should be considered in the calculation of GHG impacts. Some small pools may not justify the expense required to acquire reasonably reliable estimates of carbon contents (e.g., fine roots or fine litter); default values for carbon storage may be used in these cases (IPCC 1995; World Bank 1997b).

5.6.1. Above-ground woody biomass

Trees are usually measured standing, except at the time of thinning or felling when they can be measured on the ground. Volume is the most common measure taken and the three most frequently used parameters are stem diameter at breast height (DBH), basal area at breast height, and tree height. These parameters will give stem volume. If no allowances are made for branches and tops, then the above-ground volumes can be underestimated by a 15-50%; and if roots are not considered, then the estimated volume may only be 30-50% of actual volume (World Bank 1994a). For carbon sequestration, total above-ground volume is required and can be derived from a statistical analysis relating the measured total volume of felled trees to the parameters described above on a species-specific basis.[1] After measurements have been taken to estimate either volume or weight, these measurements must be converted to estimates of total standing stock, annual take-off and productivity. The productivity information can be taken from continuous monitoring of sample plots in the field, or from secondary sources.

5.6.2. Below-ground woody biomass

Roots store carbon and contribute to the build-up of organic soil carbon. It may be necessary to measure tree roots — either on the plots or on trees felled outside the project area, to obtain ratios between above- and below-ground woody biomass. These measurements should be compared to the rule of thumb that approximately one-third of the mass of a tree is below ground (World Bank 1994a).

5.6.3. Calculating carbon storage in woody biomass

Once stand or total tree volume or weight has been estimated, this measure must be converted into organic carbon weight. There is very little variation in chemical composition of all wood species and on an ash free, moisture free (bone dry) basis, approximately 50% of wood by weight is carbon, 6% is hydrogen, and 44% is oxygen (World Bank 1994a). Although the chemical composition of wood does not vary much, density and moisture content vary considerably by species (e.g., coniferous wood species are generally much less dense than hardwood species). Density can be determined by taking pieces of wood of known dimensions, weighing them, subtracting the weight of water, and dividing the volume into

[1] Alternatively, volume tables from previous studies can be used if they exist and are sufficiently documented to support their application to the current project; however, felling trees provides more information than pre-existing volume tables. Biomass expansion factors are widely accepted, if properly used (see Brown et al. 1989).

the bone dry weight. Moisture content can be measured by weighing the wood as received and reweighing it after it has been dried in an oven until its weight is constant. Alternatively, a moisture content meter can be used which will give a direct reading of moisture content.

5.6.4. Carbon storage in annual plants

Forestry residues can be used as renewable resources to substitute for fossil fuels. Samples need to be weighed and moisture contents need to be determined as for woody biomass. Unlike wood, there is a large variation in the ash content of different kinds of crop residues and, therefore, ash content needs to be determined in order to calculate its energy value at different moisture contents (e.g., by completely burning known bone dry weights of residues and weighing the remaining ashes afterwards). The carbon content (and energy value) of crop residues can be measured directly using a bomb calorimeter, but average values can be used as a good approximation: on an ash free, moisture free (bone dry) basis, 46% of crop residues by weight is carbon (World Bank 1994a).

5.6.5. Soil carbon

For most lands, soil (to a depth of 5 meters) is usually a greater store of carbon than is biomass tissue, with the most carbon found in forest soils, followed by grassland soils and arable agricultural soils (World Bank 1994a). Thus, the buildup of organic carbon in the soil needs to be measured throughout the project site, down to a depth of 5 meters, with emphasis on the first meter. Ideally, soil samples should be taken each year at permanent sample sites in different age and land use classes, and the buildup of soil carbon recorded yearly. Using a bomb calorimeter, the carbon content of the soil is calculated.

But soil carbon does not need to be measured as part of forestry mitigation projects, if no carbon credits are granted for changes in soil carbon associated with the project. The potentially high cost of measuring soil carbon may suggest that consideration of changes in soil carbon in many forestry mitigation projects is not economically feasible.

5.6.6. Forest products

The long-term effectiveness of carbon sequestration depends on the uses of the wood produced through project activities. The more durable the wood product, the greater the project’s carbon storage effect in the medium and long term. However, carbon stored in wood is obviously not stored permanently; organic compounds usually decay and some will ultimately reappear as GHG emissions. A monitoring and evaluation system to measure post-harvest carbon storage, particularly for medium to highly durable products, could allow reporting of additional carbon and improve the economics of projects that seek to grow higher value timber (MacDicken 1997).

An account should be made of what happens to the wood once it is felled or trees and branches die. If dead wood is regularly collected, it should be measured and its use recorded. If it is used as firewood, it may result in lower GHG impacts than if it is left to decompose. When logs, pulpwood, cord wood and chips are taken to a factory, a record should be made of the fate of this wood: e.g., waste, pulp and board products, animal bedding, fuel within the factory, fuel by households, industry, etc. Similarly, the kinds and quantity of finished products should be recorded: e.g., furniture, recycled paper, substitute for fossil fuel.

Given the inherent difficulty in determining the exact fate of wood products after they leave the forest or project area, another approach is to determine the proportion of timber that is converted into different products, and use general default values to estimate their average lifetime and decay rates (EcoSecurities 1997).

5.7. Net Carbon Impacts and Comparison Plots

The basic principle behind the evaluation of carbon storage is the comparison between the amount of carbon storage achieved under the project with the amount that would have been achieved without the project; this requires monitoring the project area as well as nonproject comparison sites prior to project startup. One can have comparison plots within the project area or outside the project area to supplement the sites within the project area. To establish the internal validity of the evaluation results, the comparison plots must be similar enough to the project area so that they can serve as a proxy for the project area under the assumption that the project was not implemented. Similarity can be established on the basis of the key factors that determine biomass productivity: rainfall, temperature, insolation, soil characteristics, species and land management. Land management or use is the most difficult criterion to meet since they could diverge significantly between comparison site and project areas. By selecting comparison plots within the project area, these divergences can be eliminated or minimized. There is no general way to ensure that the comparison plots will remain valid throughout the life of the project; special care and monitoring are needed.

5.7.1. Sampling

Sampling allows overall project performance to be assessed based on the performance of a manageable number of plots. For large, heterogeneous areas, a multi-stage approach may be appropriate, in which each stratum is divided into primary sampling units which are then subsequently divided into secondary sampling units. The type and intensity of sampling depends on the variations within each stratum. Biomass sampling studies typically aim for estimates of biomass weight or volume accurately to within ± 15% with a relatively high confidence (e.g., 90 or 95%) (World Bank 1994a).

A universally accepted level of precision for estimates of carbon benefits does not currently exist. As a general rule, the cost of a monitoring program is negatively related to the precision of the estimate of the carbon benefit. To a certain extent, the market value of carbon sequestered in carbon offset projects will determine the level of precision that is cost-effective. Some experts suggest that a reasonable target for the precision of a project's carbon benefit is a standard error of 20-30% of the mean (EcoSecurities 1997). Another option would be to adjust the carbon claims by discounting the standard error of measurements. Finally, it is unlikely that a common level of precision will be used for each of the significant carbon pools and flows.

The use of permanent sample plots is generally regarded as a statistically superior means of evaluating changes in forest conditions (MacDicken 1996). Permanent plots allow reliable and efficient assessment of changes in carbon fixation over time, provided that the plots represent the larger area for which the estimates are intended. This means that the sample plots must be subject to the same management as the rest of the project area. The use of permanent plots also allows the inventory to continue reliably over more than one rotation. Finally, permanent plots permit efficient verification at relatively low cost, compared to those that use temporary plots or plotless methods: a verifying organization can find and measure permanent plots at random to verify, in quantitative terms, the design and implementation of a project's carbon monitoring plan. For nonproject sites (e.g., savannas that are regularly burned or agricultural lands subject to tillage), permanent sample plots may not be needed and plotless sampling methods can yield acceptable levels of precision at lower cost.

There are four options for sampling design: complete enumeration, simple random sampling, systematic sampling, and stratified random sampling. For carbon inventory, stratified random sampling is generally preferred, since this often yields more precise estimates for a fixed cost than the other options (MacDicken 1996). Stratified random sampling requires stratification, or dividing the population into nonoverlapping groups. Each stratum can be defined by vegetation type, soil type, or typography. For carbon inventory, strata may be most logically defined by estimated total carbon pool weight, which largely depends on above-ground biomass, which will then be the primary strata for sampling.

Useful tools for defining strata include satellite images, aerial photographs, and maps of vegetation, soils or topography. These should be combined with ground measurements for verifying remotely-sensed images. A geographic information system (GIS) can automatically determine stratum size and the size of exclusions or buffer zones.

MacDicken (1996) provides a spreadsheet for inventory decisions which calculates sample sizes using standard formulas based on measured variation for the carbon pool to be sampled. Two approaches are proposed: (1) sample plot allocation based on fixed precision levels; and (2) optimum allocation of plots among strata given fixed inventory costs.

5.8. Summary

The unique features and diversity of forestry projects, the monitoring domain and socioeconomic issues pertaining to forestry projects, and the variety of carbon pools that might be impacted by forestry projects makes the monitoring and evaluation of forestry projects very challenging. While forestry projects offer the potential for significant carbon sequestration, the verification of carbon credit claims will necessitate significant technical and financial resources. A variety of monitoring tools are available for forestry projects (e.g., remote sensing, inventory analysis, surveys, and research studies) for determing the amount of carbon sequestered by forestry projects, each having its own advantages and disadvantages (Table 10). One of the key decisions that will need to be made will be determining the optimal level of transaction costs for implementing these methodologies.

Table 10. Advantages and Disadvantages of Forestry Monitoring Methods

Methods	Advantages	Disadvantages
Modeling	Relatively quick and inexpensive. Most useful as a complement to other methods.	Relies on highly simplified assumptions. Need to be calibrated with onsite data.
Remote Sensing and Ground Truthing	Used primarily for temperate forests, and experience could be transferred to other forests. Useful for monitoring leakage.	Has not been used to measure carbon. Not used for tropical forests so far.
Inventory Analysis of Carbon Pools	Flexible in selection of methods and precision. Peer reviewed and field tested systems available. Using control plots, can calculate net carbon sequestration.	More expensive than other methods, except for research studies.
Research Studies	Detailed monitoring. Relatively accurate.	Typically, more expensive than other methods.
Surveys	Useful for determining what was actually implemented in project. Most useful as a complement to other methods.	Does not, by itself, calculate net carbon sequestration
Monitoring of Wood Production, Use and End Products	Useful for tracking fate of wood products. Most useful as a complement to other methods.	Does not, by itself, calculate net carbon sequestration

CHAPTER 6. SUMMARY AND CONCLUSIONS

The U.S. Climate Change Initiative includes joint implementation and emissions trading as two important options for reducing emissions. The former calls for emissions credits to be transferred from the host to the investor country, in exchange for funds from the latter. Emissions credits, however, have to be incremental to a baseline, otherwise a host country could inflate its projections of future emissions and gain new funds for projects that would have happened anyway. For this purpose, MERV activities are needed to accurately determine the incremental emissions reductions, i.e., the net GHG benefits. A project will have non-GHG impacts as well, and in most instances MERV of these would be desirable to ensure that the project's GHG and other benefits are sustainable. The second option, emissions trading, can take place if there is a cap on emissions for each of the two trading countries. While the incrementality of emissions reduction is not a concern in this case, there is still a need to monitor the project performance in order to ensure that least-cost projects are implemented before others. MERV activities can help to ensure this outcome.

MERV guidelines are thus needed for climate change projects in order to accurately determine their net GHG, and other, benefits. Implementation of MERV guidelines is also intended to: (1) increase the reliability of data for estimating GHG benefits; (2) provide real-time data so that mid-course corrections can be made; (3) introduce consistency and transparency across project types and reporters; and (4) enhance the credibility of the projects with stakeholders (Andrasko et al. 1996; Palmisano 1996). In sum, new protocols and guidelines will be needed for turning GHG reductions into credible, internationally acceptable GHG credits that would trade at a single market price. The MERV issues discussed in this paper need to be worked out before putting a credible joint implementation or emissions trading system in place.

6.1. Existing GHG and Non-GHG Protocols and Guidelines

In this paper, we reviewed existing protocols and guidelines related to GHG reductions. We summarize our findings and discuss their attributes in Table 11. The guidelines developed by The World Bank and SGS Forestry offer the most information for the development of MERV guidelines for climate change mitigation projects. The topics that are not addressed in The World Bank guidelines (economic and social impacts and multiple reporting) could easily be incorporated in a revised guideline. While the focus of SGS Forestry's carbon offset verification service is on forestry projects, these guidelines are also useful for energy-efficiency and renewable energy projects. DOE's voluntary reporting guidelines lack detailed information on the evaluation of GHG emission projects, but do contain references to other reports that contain this information. These guidelines, however, do not cover some of the critical issues discussed in this report, such as: economic and social impacts, precision and accuracy, persistence, institutional issues and cost.

USIJI's project proposal guidelines, the SBSTA's uniform reporting format, and WBCSD's project proposal guidelines are more general than the other guidelines, but ask important questions that address the topics listed in Table 11. It is up to the organizations sponsoring the projects to report on evaluation methods and on some of the topics that are of concern in this report. Winrock's carbon monitoring guidelines focus primarily on forestry monitoring approaches and are not as relevant to the other topics. Finally, although not shown in Table 11, DOE's energy measurement and verification protocol and EPA's conservation and verification protocol are also very helpful for evaluating the energy savings from energy-efficiency projects.

In summary, one or more of the protocols and guidelines examined in this paper address many of the issues that need to be covered in MERV guidelines. Most of the existing protocols and guidelines, however, generally provide only broad descriptions of the issue without providing specific recommendations on responding to these issues. The most detailed discussions focus on methodologies for calculating GHG emissions (see Table 11). For the other topics, the existing protocols and guidelines highlight the importance of the issue but rely on the user to furnish the information to the best of their ability. While this approach leads to "flexibility" (as well as relatively short protocols), the guidelines may result in inconsistent responses to what is needed. MERV guidelines could adopt this same approach, or, alternatively, offer more detailed MERV recommendations (which will inevitably lead to a longer MERV or reporting document).

Table 11. Topics Addressed by Existing GHG Protocols and Guidelines

(✓ indicates that topic is addressed in protocol)

Topics Addressed	GHG Protocols and Guidelines			
	USIJI (1)	**SBSTA (2)**	**WBCSD (3)**	**World Bank (4)**
Carbon credits and trading	No	No	No	✓
GHG emissions	✓	✓	✓	✓
Energy efficiency monitoring methods	No	No	No	✓
Renewable energy monitoring methods	No	No	No	✓
Forestry monitoring methods	No	No	No	✓
Other environmental impacts	✓	✓	✓	✓
Economic and social impacts	✓	✓	✓	No
Baseline	✓	✓	✓	✓
Monitoring domain	✓	No	No	✓
Leakage	✓	✓	✓	✓
Net impacts (additionality)	✓	No	✓	✓
Self-selection bias	No	No	No	✓
Free riders	No	No	No	✓
Snapback	No	No	No	✓
Project spillover	No	No	No	✓
Market transformation	No	No	No	✓
Precision of measurement	No	No	No	✓
Confidence levels	No	No	No	✓
Sampling	No	No	No	✓
MERV frequency	No	No	No	✓
Persistence (sustainability)	✓	No	✓	✓
Multiple reporting	No	No	No	No
Verification of GHG reductions	✓	No	✓	✓
Risks and uncertainties	✓	No	✓	✓
Institutional capabilities	✓	No	✓	✓
Roles and responsibilities	✓	No	✓	✓
Qualifications	No	No	✓	✓
Manpower, training, etc.	No	No	✓	✓
Cost of MERV	✓	No	No	✓

Notes:

1. U.S. Initiative on Joint Implementation (USIJI). 1996. "Guidelines for a USIJI Project Proposal." U.S. Initiative on Joint Implementation, Washington, D.C.

2. Subsidiary Body for Scientific and Technological Advice (SBSTA). 1997. "Report of the Subsidiary Body for Scientific and Technological Advice on the Work of Its Fifth Session, Bonn, 25-28 February 1997. Annex III. Uniform Reporting Format: Activities Implemented Jointly Under the Pilot Phase." Framework Convention on Climate Change, United Nations.

3. World Business Council for a Sustainable Development (WBCSD). 1997. "Climate Change Projects: Guidelines for Completing Proposals." WWW page: www.wbcsd.climatechange.com/home.html.

4. World Bank, 1994a. "Greenhouse Gas Abatement Investment Project Monitoring & Evaluation Guidelines." The World Bank, Washington, D.C

Table 11 Continued. Topics Addressed by Existing GHG Protocols and Guidelines
(✓ indicates that topic is addressed in protocol)

	GHG Protocols and Guidelines		
Topics Addressed	**DOE(5)**	**Winrock (6)**	**SGS Forestry (7)**
Carbon credits and trading	No	✓	✓
GHG emissions	✓	✓	✓
Energy efficiency monitoring methods	✓	No	No
Renewable energy monitoring methods	✓	No	No
Forestry monitoring methods	✓	✓	✓
Other environmental impacts	✓	No	✓
Economic and social impacts	No	No	✓
Baseline	✓	✓	✓
Monitoring domain	✓	✓	✓
Leakage	✓	✓	✓
Net impacts (additionality)	✓	✓	✓
Self-selection bias	No	No	No
Free riders	✓	No	No
Snapback	No	No	No
Project spillover	✓	No	No
Market transformation	No	No	No
Precision of measurement	No	✓	✓
Confidence levels	✓	✓	✓
Sampling	✓	✓	✓
MERV frequency	No	✓	No
Persistence (sustainability)	No	No	No
Multiple reporting	✓	No	No
Verification of GHG reductions	No	No	✓
Risks and uncertainties	No	No	✓
Institutional capabilities	No	No	✓
Roles and responsibilities	No	No	✓
Qualifications	No	No	✓
Manpower, training, etc.	No	No	✓
Cost of MERV	No	✓	No

Notes:

5. U.S. Department of Energy (DOE) 1994b. "Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases Under Section 1605(b) of the Energy Policy Act of 1992." DOE/PO-0028, Volumes 2 and 3, U.S. Department of Energy, Washington, D.C.

6. MacDicken, K. 1997. "Project Specific Monitoring and Verification: State of the Art and Challenges," *Mitigation and Adaptation Strategies for Global Change*, forthcoming.

7. EcoSecurities, Ltd. 1997. "SGS Forestry Carbon Offset Verification Services." Draft. SGS Forestry, Oxford, United Kingdom.

6.2. Guiding Principles

The strictness of MERV guidelines needs to be carefully considered. Strict guidelines may easily lead to burdensome and complex procedures, thereby increasing the transaction costs and reducing the cost-effectiveness of a project. However, if the guidelines for international verification are "loose", then project sponsors might be more able to manipulate the "measured" emission reductions, e.g., inflating the net emission reductions from the project. Thus, the guidelines should not be overly burdensome but credible. There needs to be a balance between (1) the need to gather sufficient data and information to accurately measure real GHG emissions reductions and build confidence in climate change mitigation projects and (2) the need to promote efficiency by minimizing MERV burdens at all levels (Embree 1994; Heister 1996). Such a balance would limit reporting to what is necessary and reduce costs and the number of transactions among institutions and project participants.

What are the true information needs? In this paper, we have presented our list of key issues that need to be addressed. However, information needs will differ with each organization's goals with respect to climate change mitigation projects. Based on our review of existing protocols and guidelines, we expect all organizations to support sustainable GHG emissions reductions. However, options should be available for project developers to decide how much effort should be spent in addressing each MERV issue. In our investigation, we came across several examples that the guidelines should consider for providing flexibility and reducing costs and complexity in conducting MERV activities:

1. In the beginning stages of a project, leakage and the indirect impacts of a project are likely to be modest, so that the MERV of such impacts may not be a priority. These effects are also likely to be insignificant or small for small projects and for certain types of projects. Under these circumstances, it may be justified for the guidelines to disregard these impacts and base the quantification of net GHG reductions only on GHG emissions from the project and the baseline (or comparison group). This would help reduce MERV and transaction costs. As the projects become larger, these impacts should be evaluated.

2. The amount of resources devoted to MERV activities could be based on the level of uncertainty and the amount of risk sharing. For instance, three options are available to users for estimating energy savings in DOE's IPMVP guidelines (Section 2.2.1). EPA's CVP provides two different general savings paths to earn credit for energy-efficiency programs (Section 2.2.3).

3. Instead of an all-or-nothing MERV system, the guidelines could offer a multi-tiered GHG crediting approach that would vary by level of precision or by the amount of resources devoted to MERV activities(Section 3.8):[1]

   a. The guidelines could recommend precise levels of measurement with high levels of confidence (e.g., 90%), or they could be more flexible: e.g., EPA's CVP uses a 75% level of confidence without specifying a level of precision, and Winrock's guidelines provide four options for addressing precision (Section 3.4).

   b. The guidelines could recommend different MERV options. For example, EPA's CVP provides three options for verifying subsequent-year energy savings: monitoring, inspection and a default (Section 3.6). And instead of extensive monitoring and evaluation, best practical default methodologies and estimate procedures could be used (for many MERV issues), and GHG reductions could be adjusted or discounted.

6.3. Resolution of Generic MERV Issues

Some of the MERV issues are of a generic nature, whose resolution would benefit all future MERV guidelines and protocols. These issues would best be addressed through an international consensus. The consensus should:

1. Clarify, at the earliest possible date, the accepted roles and responsibilities of national governments, private businesses, nongovernment organizations, and international organizations in the joint implementation accreditation process. Clearer property rights would reduce MERV costs, by focusing these activities on the correct parties at an earlier point in time.

2. Initiate a process to certify nongovernment organizations to provide MERV services.

3. Provide guidance on the determination of a baseline. How long should a baseline remains "fixed" before a new baseline is developed? If new information becomes available after a project has been implemented, does the baseline have to remain

[1] Investors may like discounting, but governments may not prefer this option if they are interested in obtaining actual emissions reductions for meeting international protocols. On the other hand, investors may not want governments discounting their projects, because of the loss of anticipated project revenues (or carbon credits).

fixed after implementation and as specified in a certification document, or can the baseline be adjusted?

4. Decide whether MERV guidelines could exclude certain types of projects that are most likely small in scale. Also, one could specify thresholds for an accumulation of projects in the economy above which significant indirect impacts are to be expected (e.g., if 5-10% of electricity generated in a country is affected by a project).

5. Decide when a country's laws and guidelines (e.g., environmental impact statements) apply; e.g., where an investor country funds a project in a host country, do the laws of the investor country apply? or the host country? or both? And what happens if the laws from the two countries conflict?

6. Create a tribunal to resolve disputes over verification results and develop a set of MERV guidelines.

The COP and national governments should foster information exchange for joint implementation in general, and for MERV issues discussed in this report. Some progress has been made through the World Wide Web: the COP, World Bank, and national joint implementation organizations provide information on their projects, as well as project proposal criteria (e.g., a list of methodological issues being discussed in SBSTA workshops can be found on the World Wide Web: http://www.unfccc.de/fccc/ccinfo/aij_meth.htm; The World Bank's methodological work is discussed in Heister (1996) and on the World Wide Web: http://www-esd.worldbank.org/aij/psc.htm).

6.4. Concluding Thoughts

Some of the technical issues addressed in this paper are already being addressed in some joint implementation (JI) projects currently funded, although not consistently nor uniformly. Most joint implementation projects have not been evaluated:

> "There is currently little useful information available on JI projects other than the public relations materials put out by most JI sponsors and national governments. To many people, the cost data looks suspiciously low. To others, there are real questions as to the environmental benefits associated with JI projects. To still others, there are questions as to the hidden costs associated with JI and imposed upon national regulators. Only through a thorough evaluation of JI and AIJ projects can potential generators of AIJ projects and potential purchasers of post-2000 JI projects understand what, if anything, JI offers them." (Palmisano 1996)

In conclusion, there is a need to collect, analyze, summarize and disseminate the best responses to the topics addressed in this report and currently being dealt with in climate change mitigation projects. The lessons learned in these projects should be very helpful for formulating MERV guidelines for climate change mitigation projects, which is the next phase in our project. These guidelines will be "tested" using actual climate change mitigation projects, and, when necessary, they will be revised in order to correct for systematic errors.

REFERENCES

Anderson, R. 1995. "Joint Implementation of Climate Change Measures," Climate Change Series Paper No. 005, Environment Department, Global Environment Division, World Bank, Washington, D.C.

Andrasko, K. 1997. "Forest Management for Greenhouse Gas Benefits: Resolving Monitoring Issues Across Project and National Boundaries," *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):117-132.

Andrasko, K., L. Carter, and W. van der Gaast. 1996. "Technical Issues in JI/AIJ Projects: A Survey and Potential Responses," a background paper prepared for the Critical Issues Working Group, for the UNEP AIJ Conference, San Jose, Costa Rica.

Asian Development Bank. 1994. "Handbook for Incorporation of Social Dimensions in Projects."

Brown, P., B. Cabarle, and R. Livernash. 1997. "Carbon Counts: Getting the Numbers Right." World Resources Institute, Washington, D.C.

Brown, S., J. Sathaye, M. Cannell, and P. Kauppi. 1996. "Management of Forests for Mitigation of Greenhouse Gas Emissions," Chapter 24 in *Climate Change 1995 — Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses*. Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Editors R. Watson, M. Zinyowera, and R. Moss. University of Cambridge, Cambridge, UK.

Brown, S., A. Gillespie, and A. Lugo. 1989. "Biomass estimation methods for tropical forests with applications to forest inventory data, " *Forest Science* 35(4): 881-902.

De Jong, B., R. Tipper, and J. Taylor. 1997. "A Framework for Monitoring and Evaluating Carbon Mitigation by Farm Forestry Projects: Example of a Demonstration Project in Chiapas, Mexico," *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):231-246.

Department of State. 1997. "Public Notice 2471. Evaluation and Assessment of the U.S. Initiative on Joint Implementation." Bureau of Oceans and International Environmental and Scientific Affairs, Department of State, Washington, DC.

Dudek, D. and J. Wiener. 1996. "Joint Implementation, Transaction Costs, and Climate Change," OCDE/GD(96)173. Organization for Economic Co-Operation and Development, Paris.

EcoSecurities, Ltd. 1997. "SGS Forestry Carbon Offset Verification Services." Draft. SGS Forestry, Oxford, United Kingdom.

Embree, C. (Sid). 1994. "Monitoring, Accounting, Verifying, and Reporting on Joint Implementation Activities: Preliminary Issues and Considerations," presented at the Workshop on Designing Joint Project Mechanisms to Promote Benefits for Developing Countries, Rio de Janeiro, Brazil, Dec. 13-15.

Eto, J., R. Prahl, and J. Schlegel. 1996. "A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs." LBNL-39058. Lawrence Berkeley National Laboratory, Berkeley, CA.

Face Foundation. 1997. "Annual Report 1996." Arnheim, The Netherlands.

Faeth, P., C. Cort, and R. Livernash. 1994. "Evaluating the Carbon Sequestration Benefits of Forestry Products in Developing Countries." World Resources Institute and U.S. Environmental Protection Agency, Washington, D.C.

Figueres, C., A. Hambleton, L. Lay, K. MacDicken, S. Petricone, and J. Swisher. 1996. "Implementing JI/AIJ: A Guide for Establishing National Joint Implementation Programs." The Center for Sustainable Development in the Americas, Washington, D.C.

Heister, J. 1996. "Towards a Methodology for Quantifying Greenhouse Gas Offsets from Joint Implementation Projects and Activities Implemented Jointly," draft working paper, Global Climate Change Unit, Global Environment Division, World Bank, Washington, D.C.

Hickman, C. and T. Steele. 1991. "Building Site Visits as Supplement to Program Evaluation," *Proceedings of the 1991 International Energy Program Evaluation Conference,* pp. 174-180. National Energy Program Evaluation Conference, Chicago, IL.

International Panel on Climate Change (IPCC). 1995. "Greenhouse Gas Inventory Workbook and Reporting Instructions." IPCC, Bracknell.

Kats, G., A. Rosenfeld, T. McIntosh, and S. McGaraghan. 1996. "Energy Efficiency as a Commodity: The Emergence of an Efficiency Secondary Market for Savings in Commercial Buildings," *Proceedings of the 1996 ACEEE Summer Study*, Vol. 5, pp. 111-122. American Council for an Energy-Efficient Economy, Washington, D.C.

Kats, G., A. Rosenfeld, and S. McGaraghan. 1997. "Energy Efficiency as a Commodity: The Emergence of a Secondary Market for Efficiency Savings in Commercial Buildings," *Proceedings of the 1997 ECEEE*

Summer Study, Panel 2, ID 176, pp. 1-14. European Council for an Energy-Efficient Economy, Washington, D.C.

Kromer, J. and S. Schiller 1996. "National Measurement and Verification Protocols," *Proceedings of the 1996 ACEEE Summer Study*, Vol. 5, pp. 141-146. American Council for an Energy-Efficient Economy, Washington, D.C.

MacDicken, K. 1997. "Project Specific Monitoring and Verification: State of the Art and Challenges," *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):191-202.

MacDicken, K. 1996. "A Guide to Monitoring Carbon Sequestration in Forestry and Agroforestry Projects." Working Paper 96/04 (revised 9/96). Forest Carbon Monitoring Program, Winrock International Institute for Agricultural Development, Arlington, VA.

Meier, A. and B. Solomon. 1995. "The EPA's Protocols for Verifying Savings from Utility Energy-Conservation Programs," *Energy: The International Journal* 20(2);105-115 (1995).

Ministry of Economic Affairs. 1997. "Long Term Agreements on Energy Efficiency. Progress in 1995." The Hague, The Netherlands.

Moura Costa, P. 1996. "Tropical Forestry Practices for Carbon Sequestration," in *Dipterocarp Forest Ecosystems - Towards Sustainable Management*, A. Schulte and D. Schone (Eds). World Scientific, Singapore.

Moura Costa, P., M. Stuart, and E. Trines. 1997. "SGS Forestry's Carbon Offset Verification Service," EcoSecurities, Oxford, UK.

Nadel, S. 1993. "The Takeback Effect: Fact or Fiction?" *Proceedings of the 1993 International Energy Program Evaluation Conference,* August 25-27, 1993. National Energy Program Evaluation Conference, Chicago, IL.

Nuijen, W. 1997. "Long Term Agreements on Energy Efficiency Improvements In The Netherlands." Netherlands Agency for Energy and the Environment, Utrecht, The Netherlands.

Palmisano, J. 1996. "Establishing a Market in Emissions Credits: A Business Perspective." IEA Environment Briefing No. 2. Institute of Economic Affairs, London, UK.

Petersen, F. 1990. "Remodel and Tenancy Changes: Threats to the Reliability of Commercial Conservation Savings." *Proceedings of the 1990 ACEEE Summer Study on Energy Efficiency in Buildings*, Vol. 3, pp. 165-172. American Council for an Energy-Efficient Economy, Washington, DC.

Raab, J. and D. Violette. 1994. "Regulating DSM Program Evaluation: Policy and Administrative Issues for Public Utility Commissioners." National Association of Regulatory Utility Commissioners, Washington, DC.

Ravindranath, N. and P. Bhat. 1997b. "Monitoring of Carbon Abatement in Forestry Projects — Case Study of Western Ghat Project," *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):217-230.

Skole, D., C. Justice, J. Townshend, and A. Janetos. 1997. "A Land Cover Change Monitoring Program: Strategy for an International Effort, " *Mitigation and Adaptation Strategies for Global Change*, 2(2-3):157-175.

Skumatz, L., K. Lorberau, R. Mole, R. Bordner, and R. Chandler. 1991. "Bonneville Measure Life Study: Effect of Commercial Building Changes on Energy Using Equipment," Synergic Resources Corporation, Seattle, WA.

Subsidiary Body for Scientific and Technological Advice (SBSTA). 1997. "Report of the Subsidiary Body for Scientific and Technological Advice on the Work of Its Fifth Session, Bonn, 25-28 February 1997. Annex III. Uniform Reporting Format: Activities Implemented Jointly Under the Pilot Phase." Framework Convention on Climate Change, United Nations.

Swisher, J. 1996. "Facts and Myths on Joint Implementation in the Framework Convention on Climate Change," presented at the Air and Waste Management Association Conference. Econergy International Corp., Boulder, CO.

Swisher, J. 1997. "Joint Implementation Under the U.N. Framework Convention on Climate Change: Technical and Institutional Challenges," *Mitigation and Adaptation Strategies for Global Change*, 2(1):57-80.

Synergic Resources Corporation. 1992. "Dayton P&L Say Yes Program." Synergic Resources Corporation, Seattle, WA.

Train, K. and E. Paquette. 1995. "A Discrete Choice Method to Estimate Free Ridership, Net-to-Gross Ratios, and the Effect of Program Advertising," Energy Services Journal 1(1):21-34.

UNEP/WMO Information Unit on Climate Change. 1992. United Nations Framework Convention on Climate Change. UNEP/WMO Information Unit on Climate Change, Geneva, Switzerland.

U.S. Agency for International Development (AID). 1996. "Strategies for Financing Energy Efficiency," Business Focus Series. U.S. Agency for International Development, Washington, D.C.

U.S. Department of Energy (DOE). 1994a. "General Guidelines for the Voluntary Reporting of Greenhouse Gases Under Section 1605(b) of the Energy Policy Act of 1992." DOE/PO-0028, Volume 1, U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE). 1994b. "Sector-Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases Under Section 1605(b) of the Energy Policy Act of 1992." DOE/PO-0028, Volumes 2 and 3, U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE). 1996a. "Voluntary Reporting of Greenhouse Gases, 1995," DOE/EIA-0608(95). U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE). 1996b. "North American Energy Measurement and Verification Protocol," DOE/EE-0081. U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy (DOE). 1996c. "Measurement and Verification (M&V) Guidelines for Federal Energy Management Projects," DOE/GO-10096-248, U.S. Department of Energy, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1995a. "Acid Rain CEMS Program Submission Instructions." U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1995b. "Conservation and Verification Protocols, Version 2.0." EPA 430/B-95-012. U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1996. "The User's Guide to the Conservation and Verification Protocols, Version 2.0." EPA 430/B-96-002. U.S. Environmental Protection Agency, Washington, D.C.

U.S. Initiative on Joint Implementation (USIJI). 1996. "Guidelines for a USIJI Project Proposal." U.S. Initiative on Joint Implementation, Washington, D.C.

Vine, E. 1994. "The Human Dimension of Program Evaluation," *Energy - The International Journal*, 19(2):165-178.

Violette, D., M. Ozog, M. Keneipp, and F. Stern. 1991. "Impact Evaluation of Demand-Side Management Programs, Volume I and II: A Guide to Current Practice." EPRI CU-7179. Electric Power Research Institute, Palo Alto, CA.

Violette, D. and P. Hanser. 1991. "Utilizing Information from Multiple Sources in DSM Impact Evaluation," *Proceedings of the 5th National Demand-Side Conference.* July 1991. EPRI CU-7394. Electric Power Research Institute, Palo Alto, CA.

Watt, E., J. Sathaye, O. de Buen, O. Masera, I. Gelil, N. Ravindranath, D. Zhou, J. Li, and D. Intaraprvich. 1995. "The Institutional Needs of Joint Implementation Projects," LBL-36453, Lawrence Berkeley National Laboratory, Berkeley, CA.

Willems, P., J. Ciraulo, and B. Smith. 1993. "Demand-Side Management Program Evaluation and the EPA Conservation Verification Protocols," TR-103103, Electric Power Research Institute, Palo Alto, CA.

World Bank 1997a. "The Carbon Offset Investment Business and the Potential Role of the World Bank Group." Global Climate Change Unit, Global Environment Division, World Bank, Washington, D.C.

World Bank 1997b. "Guidelines for Climate Change Global Overlays." Global Environment Division, World Bank, Washington, D.C.

World Bank 1994a. "Greenhouse Gas Abatement Investment Project Monitoring & Evaluation Guidelines." World Bank, Washington, D.C.

World Bank 1994b. "Incorporating Social Assessment and Participation Into Biodiversity Conservation Projects." World Bank, Washington, D.C.

World Bank 1989. "Checklist of Potential Issues for an Environmental Assessment." Operating Manual: Section OD 4.00 — Annex A2. World Bank, Washington, D.C.

World Business Council for a Sustainable Development (WBCSD). 1997. "Climate Change Projects: Guidelines for Completing Proposals." WWW page: www.wbcsd.climatechange.com/home.html.

APPENDICES

The appendices are not contained in the electronic file of this report. However, they can be obtained via the World Wide Web.

A. USIJI's Project Proposal Guidelines: http://www.ji.org/usiji/guide.shtml

B. SBSTA's Uniform Reporting Format: http://www.unfccc.de/fccc/ccinfo/aij_urf.htm

C. Uniform Reporting Formats Completed by Other Countries:

Costa Rica:	http://www.unfccc.de/fccc/ccinfo/aijprog/aij_pcri.htm
Japan:	http://www.unfccc.de/fccc/ccinfo/aijprog/aij_pjap.htm
Norway:	http://www.unfccc.de/fccc/ccinfo/aijprog/aij_pnor.htm
Poland:	http://www.unfccc.de/fccc/ccinfo/aijprog/aij_ppol.htm
Sweden:	http://www.unfccc.de/fccc/ccinfo/aijprog/aij_pswe.htm
Switzerland:	http://www.unfccc.de/fccc/ccinfo/aijprog/aij_pch.htm

D. WBCD's Guidelines for Completing Proposals: http://www.wbcsd.climatechange.com/home.html